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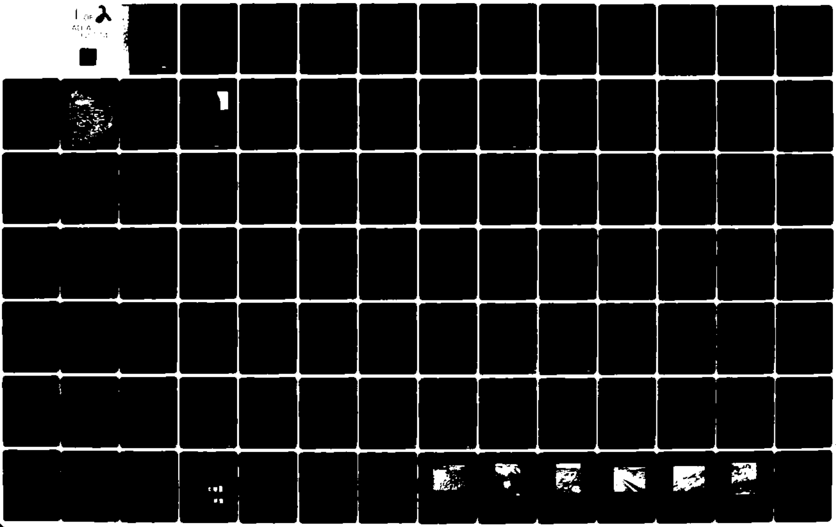

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MX SITING INVESTIGATION
GEOTECHNICAL EVALUATION

AGGREGATE RESOURCES STUDY
SNAKE VALLEY
NEVADA-UTAH

PREPARED FOR
BALLISTIC MISSILE OFFICE (BMO)
NORTON AIR FORCE BASE, CALIFORNIA

FUGRO NATIONAL, INC.
Consulting Engineers and Geologists

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This report contains the Valley-Specific Aggregate Resources Study evaluation for Snake Valley in Nevada. It is the second in a series of reports that contain valley-specific aggregate information on the location and suitability of basin-fill and rock sources for concrete and road-base construction materials. Field reconnaissance and limited laboratory testing, existing data from the Utah State Department of Highways, a previous regional aggregate investigation, and ongoing Verification studies provide the basis for the findings presented.

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AGGREGATE RESOURCES STUDY

SNAKE VALLEY

UTAH-NEVADA

Prepared for:

U.S. Department of the Air Force
Ballistic Missile Office (BMO)
Norton Air Force Base, California 92409

Prepared by:

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6 June 1980

FOREWORD

This report was prepared for the Department of the Air Force Ballistic Missile Office (BMO) in compliance with Contract No. F04704-80-C-0006, CDRL Item No. 004A2. It presents the results of Valley-Specific Aggregate Resources studies within and adjacent to selected areas in Utah and Nevada that are under consideration for siting the MX system.

This volume contains the results of the aggregate resources studies in Snake Valley. It is the second of several Valley-Specific Aggregate Resources investigations which will be prepared as separate volumes. Results of this report are presented as text, appendices, and two drawings.

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EXECUTIVE SUMMARY

This report contains the Valley-Specific Aggregate Resources Study (VSARS) evaluation for Snake Valley in Nevada. It is the second in a series of reports that contain valley-specific aggregate information on the location and suitability of basin-fill and rock sources for concrete and road-base construction materials. Field reconnaissance and limited laboratory testing, existing data from the Utah State Department of Highways, a previous regional aggregate investigation, and ongoing Verification studies provide the basis for the findings presented.

A classification system based on aggregate type and potential use was developed to rank the suitability of all basin-fill and rock aggregate sources. Four aggregate types have been designated; coarse, fine, and coarse and fine (multiple) aggregates derived from basin-fill sources and crushed rock aggregates derived from rock sources. Each aggregate type was then classified using the following definitions:

Class I — Potentially suitable concrete aggregate and road-base material source.

Class II — Possibly unsuitable concrete aggregate/potentially suitable road-base material source.

Class III — Unsuitable concrete aggregate or road-base material source.

Decisions on assigning a particular aggregate source to one of the three classes were determined from Fugro National and existing laboratory aggregate tests performed as part of this

study (abrasion resistance, soundness, and alkali reactivity), and to a lesser degree, field visual observations.

Emphasis in this study was placed on the identification of Class I basin-fill, coarse aggregate. These deposits are considered to be the primary sources of concrete and road-base construction materials. Results of the study are presented on a 1:125,000 scale aggregate resources map (Drawing 2) and are summarized as follows:

1. Coarse Aggregate - Two major Class I coarse aggregate basin-fill deposits were located in the study area.

   a. Extensive older lacustrine deposits (Aol) located along both flanks of the valley basin in the northern and central portions of Snake Valley.

   b. Alluvial fan deposits (Aafs) west of the central Confusion Range in the south-central portion of the valley.

   Specific Class II coarse aggregate sources were identified in older lacustrine deposits (Aol) west of Granite Mountain, in the northeastern portion of the valley, and north of the Burbank Hills in the southwestern portion of the study area. Other potential Class II sources are widespread and extensive in the study area and, although boundaries of specific deposits could not be delineated, they are typically located within alluvial fans (Aaf) flanking Class I and/or Class II rock sources.

2. Fine Aggregate - Most coarse aggregate basin-fill sources are also potential multiple sources (coarse and fine) that

will supply varying quantities of fine aggregates either from the natural deposit or during processing. Specific Class I fine aggregate sources were identified within the following areas:

a. Older lacustrine deposits (Aol) east of the Deep Creek Range and west of Granite Mountain (multiple type source) in the northern part of the study area and east of the Snake Range in the west-central portion of Snake Valley.

b. Alluvial fan deposits (Aafs) west of the southern Confusion Range in the northern Ferguson Desert in the south-central portion of the Snake Valley study area (multiple type source).

Potential Class II fine aggregate sources are widespread and extensive in the study area. Specific deposit boundaries could not be delineated but typically occur basinward of most Class I and Class II coarse aggregate deposits and/or rock exposures.

3. Crushed Rock - Abundant Class I crushed rock sources surround the study area and consist of:

a. Undifferentiated carbonate rocks (Cau) composed primarily of limestone and dolomite from the Guilmette Formation. The most extensive deposits are located along the eastern margin (Conger and Confusion ranges) and in the southwestern portion (Burbank Hills) of the study area;

b. Laketown Dolomite (Do) primarily exposed in the southern portion of the study area (southern Confusion Range and Tunnel Springs Mountains);

c. Eureka Quartzite (Qtz), limited in areal extent, but where exposed in the southeastern portion of the valley (southern Confusion Range) should make an excellent Class I source;

d. Basalt (Vb) exposed in a small eroded knoll in the northern portion of the study area.

The useability of any of these rock units as sources of crushed rock aggregate sources will depend on their location and accessibility within the study area and minability.

Additional aggregate testing and field investigations will be required to further refine the lateral and vertical extents of classification boundaries and define exact physical and chemical characteristics of a particular basin-fill or rock source within the valley area.

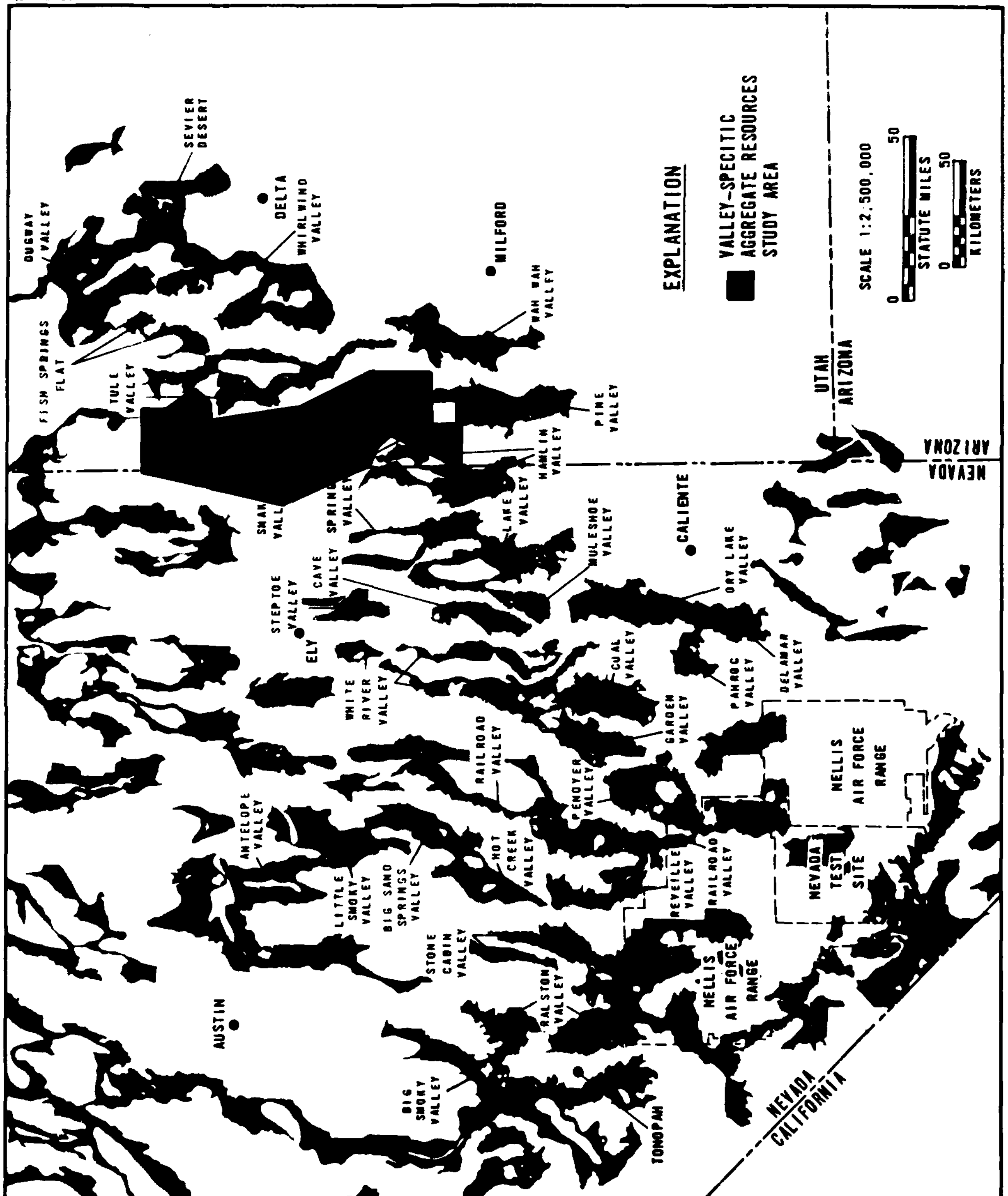
1.0 INTRODUCTION

1.1 STUDY AREA

This report presents the results of the Valley-Specific Aggregate Resources Study completed for Snake Valley (Figure 1). Located in the western portion of Juab and Millard counties, Utah, and in the eastern section of White Pine County, Nevada, the area is irregular in shape with a north-south trending alluvial basin flanked by predominantly carbonate rock mountain ranges. The Conger and Confusion ranges border the site on the east and the Snake and Deep Creek ranges and Burbank Hills form the western border.

U.S. Highway 6 provides access to the southern and central portions of the study region. A network of unpaved roads and 4-wheel-drive trails crisscross the study area (Drawing 1) and provide access to most portions of the valley.

The valley is mainly composed of desert rangeland administered by the Bureau of Land Management. Humboldt National Forest, Goshute Indian Reservation, and the Desert Range Experimental Station are located within and adjacent to the Snake Valley study area. The village of Trout Creek is situated at the northern end of the valley and the nearest major cities are Delta, Utah and Ely, Nevada, approximately 50 miles east and 80 miles west, respectively, of Snake Valley.



AGGREGATE RESOURCES STUDY
SNAKE VALLEY, NEVADA-UTAH

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - BMO

FIGURE 1

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6 JUN 80

1.2 BACKGROUND

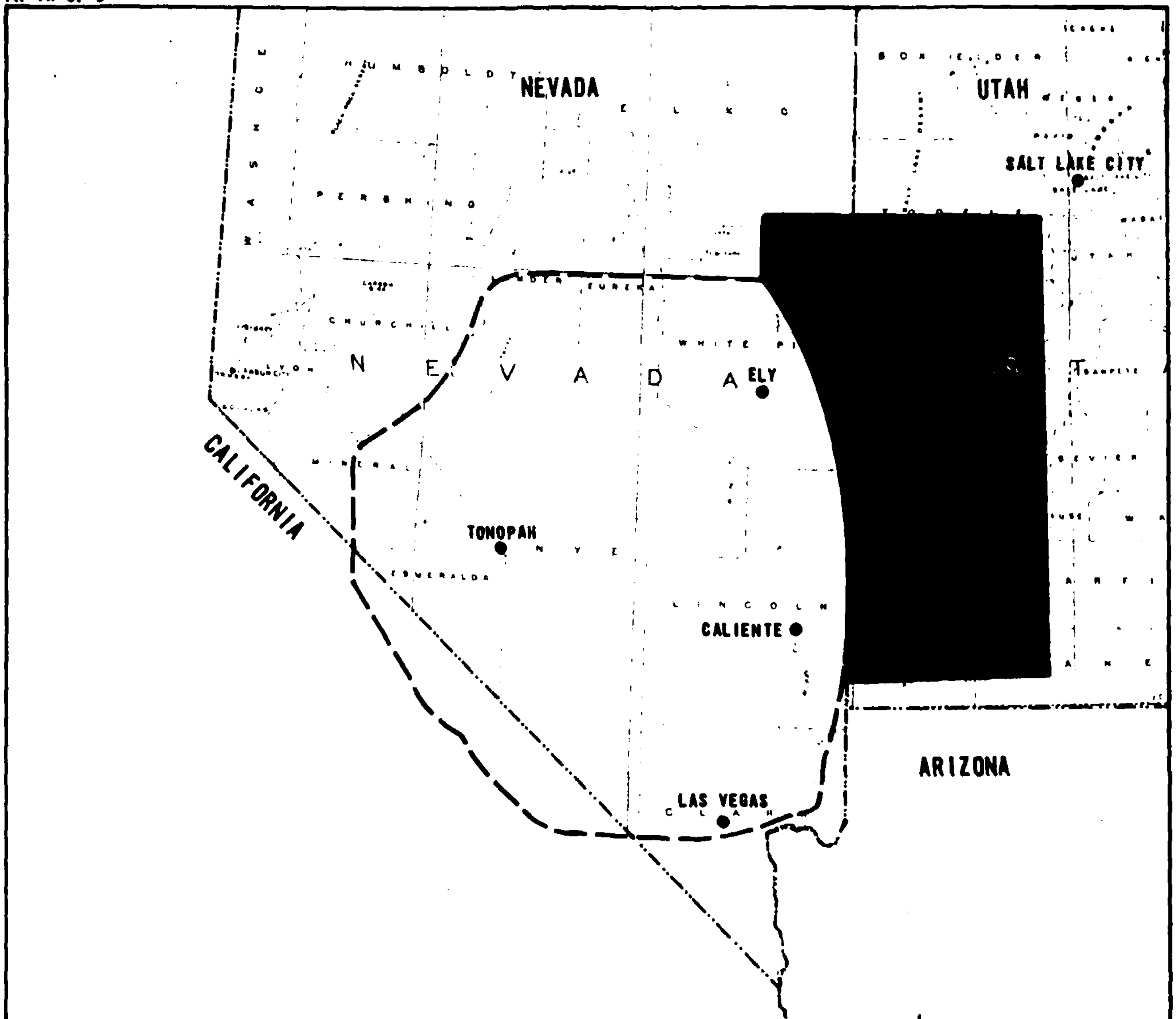
The MX aggregate program began in 1977 with the investigation of Department of Defense (DOD) and Bureau of Land Management (BLM) lands in California, Nevada, Arizona, New Mexico, and Texas (FN-TR-20D). Refinement of the MX siting area added portions of Utah and Nevada that were not studied in the initial Aggregate Resources Evaluation Investigation (AREI). This additional area (Figure 2), defined as the Utah Aggregate Resources Study area (UARSA), was evaluated in Fall 1979 and a second general aggregate resources report (FN-TR-34) was submitted on 3 March 1980. Both general aggregate investigations were designed to provide regional information of the general location, quality, and quantity of aggregates that could be used in the construction of the MX system.

Subsequent to the general studies, Valley-Specific Aggregate Resources Studies (VSARS) were developed in FY 79 to provide more detailed information on potential aggregate sources in specified valley areas.

1.3 OBJECTIVES

The primary objective of the VSARS program is to classify on a valley basis, basin-fill deposits and rock for suitability as concrete and road base construction materials. The VSARS format is designed to select and present the locations of the most acceptable aggregate sources for preliminary construction planning and follow-on, detailed aggregate investigations.

FN-TR-37-b



EXPLANATION

NEVADA-CALIFORNIA AGGREGATE RESOURCES EVALUATION INVESTIGATION FY 78 (FN-TR-20D)

UTAH AGGREGATE RESOURCES STUDY, FY 79 (FN-TR-34)

SCALE 1: 5,000,000

0 50 100
STATUTE MILES

0 50 100
KILOMETERS

UTAH-NEVADA REGIONAL AGGREGATE STUDIES

MX SITING INVESTIGATION
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FIGURE 2

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1.4 SCOPE

The scope of this investigation required office and field investigations and included the following:

(1) Collection and analysis of available existing data on the quality and quantity of potential concrete aggregate and road base material sources. American Society of Testing and Materials (ASTM) standards and Standard Specifications for Public Works Construction (SSPWC) were used to evaluate quality.

(2) Aerial and ground reconnaissance of all identified potential aggregate sources in the valley area, with more detailed investigation and sample collection of likely basin-fill (coarse and fine aggregates) and rock (crushed rock aggregates) construction material sources.

(3) Laboratory testing to supplement available existing data and to provide detailed information to assist in determining the suitability of specific basin-fill or rock deposits as construction material sources within the valley area.

(4) Development and application of an aggregate classification system (Section 2.5) that emphasizes aggregate type (coarse, fine, or crushed rock) and potential construction use (concrete and/or road base).

2.0 STUDY APPROACH

2.1 EXISTING DATA

Collection of existing test data from available sources was an important factor in the VSARS program. The principal source of existing data directly pertaining to aggregate construction materials was the State of Utah Department of Highways (Appendix A). The majority of this information is related to the use of aggregate material for asphaltic concrete, base course in road construction, or ballast material. However, many of the suitability tests for these types of construction materials are similar to those for concrete and were applicable to this investigation (Appendix A).

2.2 SUPPLEMENTAL FUGRO NATIONAL DATA

Supplemental Fugro National data were obtain from: (1) field data and supplementary test data compiled during the general aggregate resources study (FN-TR-34), (2) Snake Valley Verification study (FN-TR-27-1A), (3) Snake (south) and Snake (north) Verification studies (in progress), and (4) the current Valley-Specific Aggregate Resources Study (Appendix A).

Although the primary objective of the initial, general aggregate study was directed toward developing regional evaluations and rankings of all potential aggregate sources, the 13 data points included in the Valley-Specific study area (Drawing 1) also supplied specific aggregate information. These 13 stops contained two 100-pound samples collected for limited laboratory testing (Appendix A).

Verification geologic maps were an initial source of information on the type and extent of basin-fill units within specific valley areas. In addition, Verification study data included information from 1 trench located in the central portion of Snake Valley (Drawing 1). While the Verification studies are not specifically designed to generate aggregate data, the sampling techniques and testing procedures (Appendix A) are applicable to the aggregate evaluation.

The VSARS program required aerial and ground reconnaissance of the study area to collect additional information to verify conditions determined during the data review. Included in the 44 field station data stops was the collection of 17 samples for laboratory testing. Potential coarse and fine aggregate basin-fill samples were collected by channel sampling stream cuts or occassional man-made exposures. Potential crushed rock aggregate samples were obtained from exposures of fresh or slightly weathered material whenever possible. The weight of the samples collected range between 100 and 150 pounds. Hand samples, which generally did not exceed 5 pounds in weight, were collected for office analyses.

Identification of basin-fill materials in all field studies followed ASTM D2488-69 Description of Soils (Visual-Manual Procedure), and the Unified Soil Classification System (Appendix C). Rock identifications followed procedures described in the

Quarterly of the Colorado School of Mines and Standard Investigative Nomenclature of Constituents of Natural Mineral Aggregates (ASTM C294-69).

2.3 DATA ANALYSIS

Geologic and engineering criteria were used in the evaluation of potential aggregate sources within the study area. This was supplemented by laboratory analysis of selected samples during the Valley-Specific aggregate testing program (Table 1). Coarse aggregate is defined as plus 0.185 inch (4.699 mm) fine gravel to boulders basin-fill material. Fine aggregate is defined as minus 0.375 inch (9.52 mm) coarse to fine sand basin-fill material. While all laboratory tests supplied definitive information, the soundness, abrasion, and alkali reactivity results were considered the most critical in determining the use and acceptability of a potential aggregate source.

2.4 PRESENTATION OF RESULTS

Results of the study are presented in textual form, tables, two 1:125,000 scale maps, and appendices. Drawing 1 presents the location of the 71 existing test data and supplemental Fugro data sites within the study area. Drawing 2 presents the location of all Fugro National laboratory sample sites and all potential basin-fill and rock aggregate sources within the valley area. In addition, these potential aggregate sources are classified according to proposed aggregate use and type (Section 2.5).

ASTM TEST	SAMPLE TYPE AND NUMBER OF TESTS		
	COARSE	FINE	ROCK
ASTM C-88; SOUNDNESS BY USE OF MAGNESIUM SULFATE	9	6	5
ASTM C-131; RESISTANCE TO ABRASION BY USE OF THE LOS ANGELES MACHINE	[illegible]		5
ASTM C-136; SIEVE ANALYSIS	[illegible]	12	
ASTM C-289; POTENTIAL REACTIVITY OF AGGREGATES (CHEMICAL METHOD)	4	4	3
ASTM C-127 AND C-128; SPECIFIC GRAVITY AND ABSORPTION	8	5	5

AGGREGATE TESTS
SNAKE VALLEY
AGGREGATE RESOURCES STUDY, NEVADA-UTAH

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TABLE
1

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Geologic unit symbols utilized in Drawing 2 relate to standard geological nomenclature whenever possible. Undifferentiated basin-fill and rock units were established primarily to accomodate accuracy of data and map scale and may contain deposits which could supply significant quantities of high quality materials. A conversion table to relate these geologic symbols to Fugro geologic unit nomenclature is contained in Appendix E.

All contacts which represent distinct boundaries between geologic units are shown as solid lines in Drawing 2. The contacts are dashed where the depicted data were extrapolated beyond the limits of the source data or where accuracy of the data may be questionable. Local small deposits of one geologic unit may be found in close association with a larger deposit of a different geologic unit. Due to the reconnaissance level of the field investigation or scale limitations, these smaller deposits could not be depicted on the aggregate resources map and have been combined with the more prevalent material. Similarly, potential aggregate source classifications are preliminary and may contain lesser amounts of material of another use or type. Therefore, classification lines delimit the best aggregate evaluations possible at this level of investigation. In cases of highly variable rock or basin-fill units and limited aggregate tests, boundaries could not be drawn and information is presented as point data on Drawing 2.

Appendices contain tables summarizing the basic data collected during Fugro National's supplemental field investigations, the

results of Fugro National's supplemental testing programs, and existing test data gathered from various outside sources (Appendix A), an explanation of caliche development (Appendix B), the Unified Soil Classification System (Appendix C), photographs of typical aggregate sources within the study area (Appendix D), and a geologic unit cross reference table (Appendix E).

2.5 PRELIMINARY CLASSIFICATION OF POTENTIAL AGGREGATE SOURCES

A system was developed to preliminarily classify all potential aggregate sources in the study area. This classification is designed to present the best potential sources of coarse, fine, coarse and fine (multiple source), and crushed rock aggregate types within a Valley-Specific area (Drawing 2) based on potential aggregate use (Table 2). Concrete aggregate parameters are the principal consideration in this report as materials suitable for use as concrete aggregate are generally acceptable for use as road-base material. Therefore, the three classifications described below were based primarily on results of the abrasion, soundness, and alkali reactivity tests.

Class I — Potentially suitable concrete aggregate and road base material source. Coarse and crushed rock aggregates which either passed abrasion, soundness, and alkali reactivity tests or passed abrasion and soundness tests and were not tested for alkali reactivity; fine aggregates which either passed soundness and alkali reactivity tests or passed soundness tests and were not tested for alkali reactivity.

Class II — Possibly unsuitable concrete aggregate/potentially suitable road-base material source. Coarse, fine, and crushed rock aggregates which either failed the soundness and/or alkali reactivity tests or were classified only by field visual observations or other test data.

AGGREGATE CHARACTERISTIC[1]			AGGREGATE USE CLASSIFICATION		
			CLASS I	CLASS II	CLASS III
ABRASION RESISTANCE, PERCENT WEAR[2]			< 50	< 50	> 50
SOUNDNESS, PERCENT LOSS[3]	COARSE AGGREGATE	Na SO_4	< 12	> 12	> 12
		Mg SO_4	< 18	> 18	> 18
	FINE AGGREGATE	Na SO_4	< 10	> 10	> 10
		Mg SO_4	< 15	> 15	> 15
POTENTIAL ALKALI REACTIVITY[4]			INNOCUOUS TO POTENTIALLY DELETERIOUS	DELETERIOUS	DELETERIOUS

1. AGGREGATE CHARACTERISTIC BASED ON STANDARD TEST RESULTS
2. ASTM C131 (500 REVOLUTIONS)
3. ASTM C88 (5 CYCLES)
4. ASTM C289

PRELIMINARY AGGREGATE CLASSIFICATION SYSTEM
VALLEY-SPECIFIC AGGREGATE RESOURCES STUDY

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - BMO

TABLE 2

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Class III <u>Unsuitable concrete aggregate or road base material source</u>. Coarse and crushed rock aggregates which failed abrasion test and were excluded from further testing. Fine, and rarely, coarse aggregates composed of significant amounts of clay- and silt-sized particles.

Sources not specifically identified as Class I, II, or III from the three critical test results or clay- and silt-sized particle content, are designated as Class II sources. All classifications are preliminary with additional field reconnaissance, testing, and case history studies needed to confirm adequacy, delimit areal boundaries, and define exact physical and chemical characteristics.

The following publications/sources were used in defining the three use classifications:

(1) ASTM C33-74A Standard Specifications for Concrete Aggregate,

(2) SSPWC Part II Construction Sections 200-1.1, 1.4, 1.5, and 1.7,

(3) Literature applicable to concrete aggregates,

(4) Industrial producers of concrete aggregates, and

(5) Consultants in the field of concrete aggregates.

3.0 GEOLOGIC SETTING

3.1 PHYSIOGRAPHY

The study area lies entirely within the Basin and Range physiographic province. Primary physiographic features are controlled by block faulting which has produced the uplifted mountains and down-dropped alluvial filled basins characteristic of this region. Mountain ranges and valley basins generally trend north and south. Elevations within the valley range from about 4400 feet (1340 m) at the northern end of the study area to approximately 6100 feet (1860 m) near the southern terminus. Five mountain ranges bound the valley basin area. These are Deep Creek and Snake ranges and Burbank Hills on the west and the Confusion and Conger ranges on the east (Drawing 2). Topographic relief between mountain ridges and basins is generally greatest along the western valley margins and ranges from about 6000 feet to about 3000 feet (1830 m to 915 m). Drainage is closed within the main valley area with recent playa areas occupying the axial portion of the valley basin. A small portion of the extreme northern section of the study area drains to the north into the Great Salt Lake Desert.

3.2 LOCATION AND DESCRIPTION OF GEOLOGIC UNITS

Rocks representing the Precambrian, Paleozoic, Mesozoic, and Cenozoic eras are found in bedrock highs and mountains within and adjacent to the study area (Drawing 2).

Precambrian rocks are represented by quartzites and argillites that are exposed only in the Deep Creek Range at the northern

end of the study area. Paleozoic sediments predominantly consist of massively to thinly bedded quartzites, limestones, and dolomites with interbedded sandstones, shales, and siltstones. These sediments are widely distributed and are located in all areas but the northwestern portion of the study region. Where not exposed in bedrock highs, these rocks underlie most of the younger geologic units.

Unconformably overlying the Paleozoic rocks are Mesozoic calcareous marine shales, siltstones, and limestones which crop out in small, localized deposits within the Confusion Range. Mesozoic intrusives consist of granitic rocks which are exposed primarily within the Snake Range in the west-central portion of the study region.

Cenozoic rocks, where present, unconformably overlie older rocks. They consist of Tertiary granitic intrusives and extrusives consisting of pyroclastics, and lava flows of basaltic to rhyolitic composition. Tertiary intrusives are chiefly exposed in the Deep Creek Range and the extrusives are exposed primarily in the northern Confusion Range and in the extreme southern Tunnel Spring Mountains.

Quaternary alluvial deposits lie unconformably above all older units and consist primarily of Late Pliocene and Pleistocene alluvial fan, older lacustrine, stream channel, and terrace deposits. These units may reach a combined thickness of many thousands of feet in the valley centers.

These geologic units have been grouped into nine rock and four basin-fill units for use in discussing potential aggregate sources. The grouping of these units was based on similarities in physical and chemical characteristics and map scale limitations. The resulting units simplify discussion and presentation without altering the conclusions of the study.

3.2.1 Rock Units

Geologic rock units were grouped into nine categories (Drawing 2): quartzite (Qtz), metamorphic rocks undifferentiated (Mu), limestone (Ls), dolomite (Do), carbonate rocks undifferentiated (Cau), sedimentary rocks undifferentiated (Su), granitic rocks (Gr), basalt (Vb), and volcanic rocks undifferentiated (Vu).

3.2.1.1 Quartzite - Qtz

The Precambrian to lower Paleozoic Prospect Mountain Quartzite crops out locally in the central Snake and Deep Creek ranges (Drawing 2). This formation consists of reddish brown to white, thinly to massively bedded, well-indurated, fine-grained quartzite with interbeds of less resistant quartzite, micaceous shale, pebble conglomerate, and arkosic standstone layers. Diabase dikes and sills of basaltic appearance locally intrude this formation.

The Eureka Quartzite crops out as small units in the southern portion of the study area (Drawing 2). It is thin, generally less than 500 feet (150 m) thick, and because of its close association with undifferentiated carbonates (Cau) is often mapped with this formation. Exposures of this rock unit are located at

the south end of the Confusion Range just north of Middle Mountain. The formation is white or light gray in appearance, vitreous, sugary, fine- to medium-grained, massive orthoquartzite. Interbedded sandstone and dolomitic sandstone occurs at the top and bottom of the formation.

3.2.1.2 Metamorphic Rocks Undifferentiated

Materials classified as undifferentiated metamorphic rocks include thick complex sequences of Precambrian argillite, tillite, metaconglomerate, and quartzite mapped as part of the Big Cottonwood Series within the Deep Creek Range in the northwestern portion of the study area. The complex structure and highly interbedded nature of this series prevents further separation into individual rock types.

3.2.1.3 Limestone - Ls

Limestone is a carbonate rock which is hard, durable, medium to massively bedded and a major cliff former within the study area. Principal limestone formations within the area are all Paleozoic in age and principally include the Ely and Gerster formations. These limestones are typically medium to dark gray, fine to medium grained, fossilferous, and sparsely cherty with well-developed bedding and jointing. Limestones crop out throughout the study area. Major deposits are located within the Burbank Hills and Conger and Confusion ranges (Drawing 2).

3.2.1.4 Dolomite - Do

Dolomite is a high magnesium carbonate rock that is characteristically dark to medium gray in appearance, medium grained,

sparsely to moderately cherty and hard, with well-developed bedding and jointing. Principal formations present in the study area include the Laketown, Sevy, and Simonson dolomites in the southern Snake and southern Confusion ranges (Drawing 2).

Dolomite also crops out as minor interbeds within limestone formations, but these small outcrops are not large enough to be delineated separately due to map scale limitations and are shown as part of the larger unit.

3.2.1.5 Carbonate Rocks Undifferentiated - Cau

Materials classified as undifferentiated carbonate rocks include thick, complex sequences of limestone and dolomite with thin interbeds of sandstone, shale, and siltstone. Individual rock types are not delineated separately due to map scale limitations and the highly interbedded nature of these units. Principal formations in this unit include the upper Pogonip Group in the Snake Range, and the Guilmette Formation in the Tunnel Spring Mountains and Conger and Confusion ranges (Drawing 2). These cliff forming rocks are typically light to dark gray in appearance, thinly to massively bedded, hard, cherty, fossiliferous, and durable.

3.2.1.6 Sedimentary Rocks Undifferentiated - Su

Geologic formations mapped as undifferentiated sedimentary rocks include interbedded sandstone, shale, dolomite, limestone, and quartzite. These deposits are characterized by less well indurated material and complex thin to medium bedding. The highly interbedded nature of these units prevents separation

into individual rock types (limestone, dolomite). Principal geologic formations included with this unit are the Chainman Shale exposed in the Burbank Hills and the Arcturas Formation which chiefly crops out in the Burbank Hills and the Confusion Range (Drawing 2). Several smaller exposures of this unit are located throughout the study area.

3.2.1.7 Granite Rocks - Gr

Granitic rocks are present in the Deep Creek Range as large Tertiary intrusives and as smaller Mesozoic intrusives in the Snake Range (Drawing 2). These rock units are characteristically light gray, poorly jointed, and exhibit well-developed spheroidal weathering. The granites are composed of medium to coarse grained equidimensional minerals of quartz, plagioclase and orthoclase feldspar, and mica.

3.2.1.8 Basalt - Vb

Tertiary basalt is present in the northern portion of the study area north of Granite Mountain (Drawing 2) and may underlie the adjacent older lacustrine and alluvial deposits. Where observed, it is characteristically dense, dark gray to black, medium to thickly bedded, locally vesicular and poorly jointed with scattered interbeds of volcanic agglomerate and pumice.

3.2.1.9 Volcanic Rocks Undifferentiated - Vu

Undifferentiated volcanic rocks of the Needles Range Formation locally occupy a small area in the southern Tunnel Spring Mountains (Drawing 2). These rocks are Tertiary in age and consist predominantly of pyroclastic material of intermediate

volcanic composition. The individual lithologies comprising this unit have not been delineated separately because of map scale limitations and complex but similar composition.

3.2.2 Basin-Fill Units

Four basin-fill units are mapped and labelled within the study area (Drawing 2). These consist of older lacustrine (Aol), alluvial fan (Aaf), stream channel and terrace (Aal), and undifferentiated alluvial deposits (Au). Gravel (g) and sand (s) grain-size designations have been assigned basin-fill units in the Verification mapped areas (e.g. Aafg). Recent playa deposits, a fifth basin-fill unit, are also present in the study area but are minor in extent. They are labelled as unsuitable aggregate sources and will not be discussed.

3.2.2.1 Older Lacustrine Deposits - Aol

Older lacustrine deposits formed during Late Pliocene/Early Pleistocene time in response to a much wetter climate are one of the most extensive of the basin-fill deposits within the study Snake Valley study area. These deposits are located in the central and northern portions of the valley at topographically higher elevations than recent playa deposits in the valley centers (Drawing 2). They range from coarse gravel to sand, silt, and clay and are usually intermixed with or overlain by alluvial fan deposits. Classification of these deposits depends primarily on texture and clast composition.

3.2.2.2 <u>Alluvial Fan Deposits - Aaf</u>

Alluvial fans that border the mountain fronts and extend out into the valley basins form an extensive basin-fill unit within the Snake Valley study area (Drawing 2). They are typically heterogeneous to poorly stratified mixtures of boulders, cobbles, gravel, sand, silt, and clay that grade from very coarse grained near the rock/ alluvium contact to fine grained near the valley centers. Individual fan units contain poorly to well graded, angular to subangular particles that exhibit considerable lateral and vertical textural variation. Compostion of the surrounding source rock strongly controls the textural properties of material found in alluvial fan deposits. Fan units formed at the base of carbonate or quartzitic rocks are characteristically coarse grained, whereas fans developed from volcanic sources tend to be finer grained.

Caliche development in soils, a natural process of soil development in arid climates, ranges from none in younger fans to Stage III (Appendix B) in older units.

3.2.2.3 <u>Stream Channel and Terrace Deposits - Aal</u>

Stream channel and terrace deposits within the study area are primarily associated with secondary ephmeral streams which commonly transect alluvial fan deposits and trend normal to the ranges toward the valley axis. There, they terminate in the central valley in playa areas or poorly developed primary drainages. Most of these deposits are too small to be depicted on Drawing 2 and have been grouped with adjacent, more prominent

units (i.e., older lacustrine, alluvial fan). Stream channel deposits vary from homogeneous to poorly stratified mixtures of sand, gravel, cobbles, and boulders near mountain fronts to sands, silts, and clays near valley centers.

3.2.2.4 Alluvial Deposits Undifferentiated - Au

Undifferentiated alluvial deposits consist of wind blown sheet and dune sands that were delineated and mapped during the Verification program. The deposits are located in the southeastern portion of the study area and consist of crossbedded fine to coarse sands.

4.0 POTENTIAL AGGREGATE SOURCES

Based on the results of field visual observations and aggregate testing, potential basin-fill and rock sources were divided into three material types (i.e., coarse, fine, and crushed rock) and classified into one of the three use categories (Section 2.5). Basin-fill deposits tested in the study area may be placed within a multiple type category, (coarse and fine aggregate source). Coarse aggregate is defined as plus 0.185 inch (4.699 mm) fine gravel to boulders and fine aggregate is defined as minus 0.375 inch (9.52 mm) coarse to fine sand.

Classification boundaries (Drawing 2) of basin-fill aggregate sources were generalized and will require additional studies to accurately define their location. Boundaries of identified crushed rock sources are based on the areal map extent of the geologic formations tested (i.e., Prospect Mountain Quartzite, Guilmette Formation, Pogonip Group) and not on the aggregate geologic units (i.e., Qtz, Cau) described in Section 3.2.1.

In the following discussion, the best potential coarse, fine, or crushed rock source within each Class I and Class II category is presented first; followed by sources with successively lower potential. This ranking of deposits is preliminary and based upon an analysis of all Fugro National and existing data.

4.1 BASIN-FILL SOURCES

4.1.1 Coarse Aggregate

4.1.1.1 Potentially Suitable Concrete Aggregate and Road Base Material Sources - Class I

Extensive Class I coarse aggregate sources (Aol) are located in older lacustrine deposits along both flanks of the northern and central valley basin (Drawing 2). These deposits predominantly consist of poorly graded, lenticular and/or stratified, medium dense to loose sandy gravel with slightly weathered subangular and subrounded carbonate and quartzitic clasts. Laboratory test date indicate these deposits have acceptable abrasion and soundness losses for a Class I sources. Alkali reactivity tests were inconclusive and will require additional testing to determine the potential reactivity. Sieve analyses suggest that these deposits contain 20 to 33 percent sand and a sufficient amount of material for crushing. Overburden averages approximately 1 meter and consists predominantly of caliche cemented sandy gravel (stage II). Additional field reconnaissance and testing will be necessary to refine the limits of these generally depicted sources.

Access to these deposits is provided by several unpaved roads that crisscross the area and minability is considered good to excellent.

Class I coarse aggregate deposits are also present in alluvial fan deposits (Aaf, Aafs) west of the central Confusion Range (Drawing 2). These deposits consist of poorly graded, medium dense, crudely stratified, sandy gravel composed primarily of

subangular limestone and dolomite clasts. Sand comprises from 33 to 49 percent of these deposits. Laboratory tests on samples from these sources indicate acceptable abrasion and soundness losses for a Class I coarse aggregate. Alkali reactivity tests were not performed.

Boundaries of these sources could not be drawn at this level of investigation and will require additional field reconnaissance to accurately define limits. Good access to these deposits is provided by several unpaved roads and minability is considered good to excellent.

Field observations indicate additional sources of Class I coarse aggregate may be located near the rock/alluvium contact of most of the Class I and/or Class II carbonate and quartzite rock units bordering the valley basin.

4.1.1.2 Possibly Unsuitable Concrete Aggregate/Potentially Suitable Road-Base Material Sources - Class II

Class II coarse aggregate sources are present in older lacustrine deposits (Aol), west of Granite Mountain, in the northeastern portion of the valley, and north of the Burbank Hills in the southwestern section of the study area (Drawing 2). These deposits consist of medium dense, poorly graded, lenticular, and stratified sandy gravel which contain subrounded quartzite, carbonate and basaltic clasts. Abrasion and soundness test results are acceptable for Class I standards, however, alkali reactivity test results proved deleterious resulting in a Class II ranking

for both sources. Overburden thickness averages approximately 1 meter consist of caliche cemented sandy gravels (stage II).

Although approximate bondaries of the Granite Mountain source were depictable, they could not be drawn for the source northwest of the Burbank Hills at this level of investigation. The minability and access should generally be good to excellent for both sources.

Additional Class II coarse aggregate deposits may also be available from alluvial fan units (Aaf) located near the rock/alluvium contact of most Class I and Class II crushed rock sources.

4.1.1.3 Unsuitable Concrete Aggregate or Road-Base Material Sources - Class III

No unsuitable coarse aggregate sources were identified in the Snake Valley study area during the Valley-Specific investigation.

4.1.2 Fine Aggregate

4.1.2.1 Potentially Suitable Concrete Aggregate and Road-Base Material Sources - Class I

Class I fine aggregate sources are located in predominantly coarse, older lacustrine deposits (Aol) in the northern and western part of the study area along the eastern flanks of the Deep Creek and Snake ranges (Drawing 2). They consist of poorly graded, moderately dense, crudely stratified gravelly sand and sandy gravel. Soundness and alkali reactivity test results are acceptable for Class I fine aggregate. Carbonate and quartzitic

gravel clasts comprise between ten to 62 percent of these deposits and were tested, yielded acceptable Class I results (Section 4.1.1.1). However, additional testing will be necessary to accurately define the limits of fine and coarse, multiple and sole source deposits. Access and minability of these sources are considered good to excellent.

A Class I fine aggregate source was identified in older lacustrine deposits (Aol) west of Granite Mountain in the northern portion of the study area. It is a generally defined, multiple type source with, both Class I and Class II coarse aggregate fractions. The deposit consists of poorly graded, crudely to well stratified, dense, sandy gravel/gravelly sand containing up to 54 percent sand. Soundness and alkali reactivity test results were well within fine aggregate standards (see Sections 4.1.1.1 and 4.1.1.2 for discussion of coarse aggregates). This deposit will provide an easily accessible and minable source of Class I fine aggregate and Class I and/or II coarse aggregate material.

A multiple Class I fine and coarse aggregate source was also identified in alluvial fan deposits (Aafs) located west of the central Confusion Range in the northern Ferguson Desert area (Drawing 2). Field observations indicate the deposit is poorly graded, lensed to crudely stratified, loose, gravelly sand. Gravel comprises over 45 percent of this deposit and consists of subangular limestone and dolomite clasts. Test results indicate acceptable abrasion and soundness losses for Class I sources for

both fine and coarse aggregate. Alkali reactivity tests were not completed on either the fine or coarse fraction of this deposit. Overburden thickness averages about 1 meter.

Additional field reconnaissance and testing are required to define the boundaries of this source. Access and minability of this multiple source is considered good to very good.

Based of field observations, additional Class I fine aggregate sources may exist in alluvial fans located adjacent to most Class I and/or Class II crushed rock sources and older lacustrine basin-fill sources located in the northern and central portions of the valley basin (Drawing 2).

4.1.2.2 Possibly Unsuitable Concrete Aggregate/Potentially Suitable Road-Base Material Sources - Class II

A specific Class II fine aggregate source was identified in coarse, older lacustrine deposit (Aolg) within the Ferguson Desert north of the Burbank Hills, in the southern portion of the valley (Drawing 2). This localized unit within the coarse deposit consists of loose, poorly graded, crudely stratified, gravelly sand containing less than ten percent gravel. Although soundness test results were within Class I standards, alkali reactivity proved deleterious and the deposit was given a Class II rating. The overburden thickness is less than 1 meter. Excellent access is provided by U.S. Highway 6 and numerous unpaved roads. The minability is considered very good.

A specific Class II fine aggregate source was also located in an alluvial fan deposit (Aafs) located within the Ferguson Desert

in the south central portion of the study area (Drawing 2). The deposit consists of poorly graded, homogeneous, medium dense, gravelly sands with gravels comprising approximately 30 percent of the unit. A soundness test was completed on the fine fraction with losses unacceptable for Class I standards, resulting in a Class II rating. Although testing was not completed on the coarse fraction, it may provide an addtional source of Class I or Class II coarse aggregate. Overburden thickness is less than 1 meter and good access to this deposit is provided by numerous unpaved roads. Minability is considered good to excellent.

Boundaries of both of these specific Class II fine aggregates could not be delineated during this investigation and additional studies will be needed to accurately define the limits of potential sources. Additional Class II fine aggregate sources should be available from most Class I and Class II basin-fill areas on Drawing 2.

4.1.2.3 Unsuitable Concrete Aggregate or Road-Base Material Sources - Class III

Class III fine aggregate sources are located in the valley basins and are comprised predominantly of older lacustrine and recent playa deposits (Drawing 2). These sediments are typically interbedded and stratified, moderately dense, fine sand, silt, and clay.

4.2 CRUSHED ROCK SOURCES

4.2.1 Potentially Suitable Concrete Aggregate and Road Base Material Sources - Class I

Class I crushed rock sources are widely distributed throughout the study area. The most extensive deposits occur in the northern and southern portions of the Confusion Range and the central section of the Conger Range along the eastern margin of the valley, and in the Burbank Hills at the southern end of the study area. These deposits consist of undifferentiated carbonate rocks from the Guilmette Formation (Cau) and the Laketown Dolomite (Do).

Field observations of limestone from the Guilmette Formation (Cau) suggests that this rock unit is moderately hard to hard and has favorable splitting characteristics. laboratory testing indicate that abrasion and soundness losses are moderate and low, respectivity, and alkali reactivity results are within Class I standards. Deleterious materials consisted of minor amounts of chert.

Very good access to the deposits in the southern Confusion and Conger ranges is provided by U.S. Highway 6 and numerous unpaved roads. Good access to deposits in the northern Confusion Range and the Burbank Hills is provided by unpaved roads. Minability is considered good to very good, depending primarily on the slope of the terrain and the repose of the rock unit.

Laketown Dolomite (Do) forms Class I crushed rock sources in the Tunnel Springs Mountains and southern Confusion Range.

Abrasion, soundness, and alkali reactivity test results are all well within Class I requirements. Field observations indicate that this formation is generally hard, fine grained, has slabby splitting characteristic and minor amounts of deleterious materials. Existing unpaved roads provide good access to exposures of this formation and the minability of this unit is generally considered good to very good.

Although of limited aerial extent, Eureka Quartzite forms a Class I crushed rock source in the southern Confusion Range, northeast of Middle Mountain. Data from laboratory testing indicates that this formation has a high but acceptable abrasion loss and low soundness loss. An alkali reactivity test was not made on this unit. Field observations suggest these rocks are typically very hard, have slabby splitting characteristics and no deleterious materials. Very good access is provided by unpaved roads and minability is considered good for this unit.

Basalt (Vb) comprises a Class I crushed rock source within a small eroded knoll exposed in basin-fill deposits north of Granite Mountain. Laboratory results are acceptable for Class I abrasion and soundness tests, although, alkali reactivity tests proved potentially deleterious for this source. These rocks tend to be very hard and have blocky splitting characteristics. Field observations indicate that the quality of the basalt decreases when basaltic flows are interlayered with ignimbrites. The size and frequency of vesicles in the basaltic mass may also influence the quality of this potential aggregate source.

Access and the minability of this deposit are considered good to excellent.

A Class I crushed rock classification was assigned to granitic rocks (Gr) located at the northern end of the study area. Poor access and unfavorable outcrop exposure prevented sampling and testing of the main granitic rock unit in the Deep Creek Range. Samples were collected from a slightly metamorphosed outlier to the south and an outlier to the east. Test results for both deposits are acceptable for Class I abrasion and soundness standards, however, no alkali reactivity tests were performed. Field observations indicate that the granitoid rocks are moderately hard to hard, fine to very coarse grained, and display spheroidal type weathering and massive to slabby splitting characteristics. No deleterious materials were identified. Boundaries of the slightly metamorphised source are tentative where shown and will require further field reconnaissance and testing for verification. Boundaries could not be drawn around the limited exposure to the east because of the map scale. Access and minability are considered fair to good for these sources.

4.2.2 Possibly Unsuitable Concrete Aggregate/Potentially Suitable Road-Base Material Sources Class II

No Class II crushed rock aggregate sources were specifically identified from the laboratory testing program. Extensive rock units indicated on Drawing 2 as Class II crushed rock sources were classified only by field visual observations.

Paleozoic carbonates (Cau, Do, Ls) and undifferentiated sedimentary rocks (Su) comprise the predominant rock types in this classification.

4.2.3 Unsuitable Concrete Aggregate or Road-Base Material Sources - Class III

No Class III crushed rock sources were identified within the Snake Valley study area during this investigation.

5.0 CONCLUSIONS

Results of the Valley-Specific aggregate investigation indicate that potentially good to high quality (Classes I and II) basin-fill and crushed rock aggregate sources are present within the Snake Valley-Specific study area to meet construction requirements of the MX system (Drawing 2).

5.1 POTENTIAL BASIN-FILL AGGREGATE SOURCES

5.1.1 Coarse Aggregate

Major Class I coarse aggregate deposits listed in order of potential suitability, have been identified within the following areas:

a. Extensive older lacustrine deposits (Aol) located along both flanks of the valley basin in the northern and central portions of Snake Valley.

b. Alluvial fan deposits (Aafs) west of the central Confusion Range in the south-central portion of the valley.

Field observations indicate additional sources of Class I coarse aggregate may be available in alluvial fan deposits adjacent to the rock/ alluvium contact of Class I and/or Class II crushed rock sources.

Specific Class II coarse aggregate source was identified in older lacustrine deposits (Aol) west of Granite Mountain in the northeastern portion of the valley and north of the Burbank Hills in the southwestern portion of the study area. Other potential Class II sources are widespread and extensive in the study area and, although boundaries of specific deposits could

not be delineated, they are typically located within alluvial fans (Aaf) flanking Class I and/or Class II rock sources.

5.1.2 Fine Aggregate

While most coarse aggregate sources will supply quantities of fine aggregate either from the natural deposits or during processing, several fine aggregate sources were sampled and tested.

a. Older lacustrine deposits (Aol) east of the Deep Creek Range and west of Granite Mountain (multiple type source) in the northern part of the study area and east of the Snake Range in the west-central portion of the valley.

b. Alluvial fan deposits (Aafs) west of the southern Confusion Range in the northern Ferguson Desert in the south-central portion of the Snake Valley study area (multiple type source).

Further field reconnaissance will be required to identify and delineate additional Class I fine aggregate sources, however, based on field observations, potential sources may exist in alluvial fan units derived from Class I and/or Class II rock sources.

Potential Class II fine aggregate sources are widespread and extensive in the study area. Specific deposit boundaries could not be delineated but typically occur basinward of most Class I and Class II coarse aggregate deposits and/or rock exposures.

5.2 POTENTIAL CRUSHED ROCK AGGREGATE SOURCES

Class I crushed rock sources exist in most sections of the study area. The most suitable deposits and their corresponding locations are listed as follows.

a.	Undifferentiated Carbonate Rocks (Cau) Guilmette Formation.	- Southwestern and eastern Snake Valley. (Burbank Hills and the Conger and Confusion ranges)
b.	Laketown Dolomite (Do)	- Southern Snake Valley (southern Confusion Range and Tunnel Springs Mountains)
c.	Eureka Quartzite (Qtz)	- Southeastern portion of Snake Valley (southern Confusion Range)
d.	Basalt (Vb)	Northern Snake Valley (north of Granite Mountain)

Class I crushed rock sources, exposed within the Conger and Confusion ranges, because of their close proximity to the central valley basin and good to excellent minability, could provide crushed rock material for much of the study area.

Undifferentiated volcanics, limestones, dolomites, and undifferentiated sedimentary units, which are widely distributed throughout the study area comprise most of the Class II crushed rock sources delineated on Drawing 2.

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APPENDIX A

Fugro National Field Station and Supplementary
Test Data and Existing Test Data Summary Tables -
Snake Valley

EXPLANATION OF FUGRO NATIONAL FIELD STATION AND SUPPLEMENTARY TEST DATA

Fugro National field stations were established at locations throughout the Valley-Specific study area where detailed descriptions of potential basin-fill or rock aggregate sources were recorded (Drawing 1). All field observations and laboratory test data on samples collected at selected stations are presented in Table A-1. Data entries record conditions at specific field station locations that have been generalized in the text and Drawing 2. Detailed explanations for the column headings in Table A-1 are as follows:

Column Heading	Explanation
Map Number	This sequentially arranged numbering system was established to facilitate the labelling of Fugro National field station locations and existing data sites on Drawing 1 and to list the correlating information on Tables A-1 and A-2 in an orderly arrangement.
Field Station	Fugro National field station data are comprised of information collected during: o The Valley-Specific Aggregate Resources Study; sequentially numbered field stations were completed by two investigative teams (A and B). The Snake Candidate Deployment Area (DLCDP) designation is obsolete. The presently understood study area consists of Snake Valley. o The general aggregate investigation in Utah (U). o The Verification study in Snake (S) Valley; trench data (T) were restricted to information below the soil horizon (1 to 2 meters).

Column Heading	Explanation
Location	Lists major physiographic or cultural features in/or near which field stations or existing data sites are situated.
Geologic Unit	Generalized basin-fill or rock geologic units at field station or existing data locations. Thirteen classifications, emphasizing age and lithologic distinctions were developed from existing geologic maps to accomodate map scale of Drawing 2.
Material Description	Except in cases where soil or rock samples were classified on laboratory results, the descriptions are based on field visual observations utilizing the Unified Soil Classification System (See Appendix C for detailed USCS information).
Field Observations	
Boulders and/or Cobbles, Percent	The estimated percentage of boulders and cobbles is based on an appraisal of the entire deposit. Cobbles have an average diameter between 3 and 12 inches (8 and 30 cm); boulders have an average diameter of 12 inches (30 cm) or more.
Gravel	Particles that will pass a 3-inch (76 mm) and are retained on No. 4 (4.75 mm) sieve.
Sand	Particles passing No. 4 sieve and retained on No. 200 (0.075 mm) sieve.
Fines	Silt or clay, soil particles passing No. 200.
Plasticity (Index)	Plasticity index is the range of water content, expressed as percentage of the weight of the oven-dried soil, through which the soil is plastic. It is defined as the liquid limit minus the plastic limit. Field classification followed standard descriptions and their ranges are as follows:

None	- Nonplastic (NP)	(PI, 0 - 4)
Low	- Slightly plastic	(PI, 4 - 15)
Medium	- Medium plastic	(PI, 15 - 30)
High	- Highly plastic	(PI, > 31)

Column Heading	Explanation
Hardness	A field test to identify materials that are soft or poorly bonded by estimating their resistance to impact with a rock hammer; classified as either soft, moderately hard, hard, or very hard.
Weathering	Changes in color, texture, strength, chemical composition or other properties of rock outcrops or rock particles due to the action of weather; field classified as either fresh or slight(ly) moderate(ly) or very weathered.
Deleterious Materials	Substances potentially detrimental to concrete performance that may be present in aggregate; includes organic impurities, low density material, (ash, vesicules, pumice, cinders), amorphous silica (opal, chert, chalcedony), volcanic glass, caliche coatings, clay coatings, mica, gypsum, pyrite, chlorite, and friable materials, also, aggregate that may react chemically or be affected chemically by other external influences.

Laboratory Test Data

Sieve Analysis (ASTM C 136)	The determination of the proportions of particles lying within certain size ranges in granular material by separation on sieves of different size openings; 3-inch, 1 1/2-inch, 3/4-inch, 3/8-inch, No. 4, No. 8, No. 16, No. 30, No. 50, No. 100 and No. 200.
No. 8, No. 50	Asterisked entries used No. 10 and No. 40 sieves, respectively.
Abrasion Test (ASTM C 131)	A method for testing abrasion resistance of an aggregate by placing a specified amount in a steel drum (the Los Angeles testing machine), rotating it 500 times, and determing the material worn away.
Soundness Test (ASTM C 88) CA, FA	CA = Coarse Aggregate FA = Fine Agregate The testing of aggregates to determine their resistance to disintegration by saturated solutions of magnesium sulfate. It furnishes information helpful in judging the soundness of aggregates subject to weathering action, particularly when adequate

Column Heading	Explanation
	information is not available from service records of the material exposed to actual weathering conditions.
Specific Gravity and Absorption (ASTM C 127 and 128)	Methods to determine the Bulk Specific Gravity, Bulk SSD Specific Gravity (Saturated - Surface Dry Basis), and Apparent Specific Gravity and Absorption as defined in ASTM E12-70 and ASTM C 125, respectively.
Alkali Reactivity (ASTM C 289)	This method covers chemical determination of the potential reactivity of an aggregate with alkalies in portland cement concrete as indicated by the amount of reaction during 24 hours at 80°C between 1 N sodium hydroxide solution and aggregate that has been crushed and sieved to pass a No. 50 (300- m) sieve and be retained on a No. 100 (150- m) sieve.
Aggregate Use	I = Class I; potentially suitable concrete aggregate and road-base material source. II = Class II; possibly unsuitable concrete aggregate/potentially suitable road-base material source. III = Class III; unsuitable concrete aggregate or road base material source. c = coarse aggregate f = fine aggregate f/c = fine and coarse aggregate cr = crushed rock All sources not specifically identified as Class I, II, or III from the abrasion, soundness, or alkali reactivity tests or the content of clay- and silt-sized particles, are designated as Class II sources.

MAP NUMBER	FIELD STATION	LOCATION	GEOLOGIC UNIT	MATERIAL DESCRIPTION	USCS SYMBOL	BOULDERS AND/OR COBBLES, PERCENT	DISTRIBUTION MATERIAL FI[NER] THAN COBBLE[S] PERCENT	
							GRAVEL	SAND
1	SECDP-A1	Kings Canyon	Ls	Limestone				
2	SECDP-A2	Kings Canyon	Ls	Limestone				
3	SECDP-A3	Snake Valley	Aafg	Gravelly Sand	SP/GP			
4	SECDP-A4	Snake Valley	Aafs	Gravelly Sand	SP	T	35	60
5	SECDP-A5	Ferguson Desert	Aols	Gravelly Sand	SP			
6	SECDP-A6	Burbank Hills	Ls	Limestone				
7	SECDP-A7	Ferguson Desert	Aals	Sandy Gravel	GP	T	60	35
8	SECDP-A8	Ferguson Desert	Qtz	Quartzite				
9	SECDP-A9	Snake Valley	Aolg	Sandy Gravel	GP			
10	SECDP-A10	Ferguson Desert	Do	Dolomite				
11	SECDP-A11	Snake Pass	Do	Dolomite				
12	SECDP-A12	Cowboy Pass Valley	Aaf	Sandy Gravel	GP			
13	SECDP-A13	Snake Valley	Vb	Basalt				

FIELD OBSERVATIONS							SIEVE ANALYSIS, PERCENT PASSING (ASTM C 1								
DISTRIBUTION OF MATERIAL FINER THAN COBBLES, PERCENT			PLASTICITY	HARDNESS	WEATHERING	DELETERIOUS MATERIALS									
GRAVEL	SAND	FINES					3"	1½"	¾"	⅜"	NO. 4	NO. 8	NO. 16	NO. 30	NO 50
				Mod. Hard	Moderate	5 to 10% Chert, Caliche Coatings									
				Mod. Hard	Moderate	None									
			None			4% Chert	100	96.3	90.1	73.0	51.0	34.5	24.0	18.3	11.
5	60	5	None			15% Decomposed Volcanics									
			None			<5% Volcanic Glass		100	99.5	96.4	89.9	84.3	57.7	9.3	5.
				Hard	Slight	None									
0	35	5	None			Caliche Coatings, No Chert									
				Very Hard	Fresh	None									
			None			Extensive Caliche Development	97.5	91.7	80.4	67.3	50.9	40.9	30.1	17.9	8.
				Very Hard	Fresh	None									
				Very Hard	Slight	Scattered Cherty Layers									
			None			Caliche Coatings	100	98.8	90.3	71.0	48.1	33.9	23.7	17.2	13.
				Very Hard	Fresh	Chert									

LABORATORY TEST DATA

(ASTM C 136)				ABRASION TEST (ASTM C 131)	SOUNDNESS TEST (ASTM C 88)		SPECIFIC GRAVITY AND ABSORPTION (ASTM C 127 AND C 128)								ALKALI REACTIVITY (ASTM C 289	
							COARSE AGGREGATE				FINE AGGREGATE					
							SPECIFIC GRAVITY				SPECIFIC GRAVITY					
NO. 30	NO. 50	NO. 100	NO. 200	PERCENT WEAR	PERCENT LOSS CA	PERCENT LOSS FA	BULK	BULK SSD	APPARENT	PERCENT ABSORPTION	BULK	BULK SSD	APPARENT	PERCENT ABSORPTION	CA	F
				28.8	2.43		2.63	2.65	2.67	0.60					Innocuous	
18.3	11.4	1.9	0.6	40.3	4.24	13.91	2.67	2.69	2.73	0.77	2.53	2.55	2.65	1.75		
9.3	5.9	4.5	2.2			7.78					2.45	2.53	2.66	3.20		Dele
				40.8	7.95		2.62	2.63	2.65	0.43						
17.9	8.3	3.5	1.9	34.1	8.97		2.47	2.54	2.67	3.10					Deleterious	Pot Del
				19.1	0.48		2.86	2.87	2.87	0.07					Innocuous	
17.2	13.0	8.0	2.0	26.6	2.12		2.62	2.65	2.72	1.52						
				46.1	6.70		2.33	2.37	2.43	1.85					Potentially Deleterious	

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S TEST 88) LOSS FA	SPECIFIC GRAVITY AND ABSORPTION (ASTM C 127 AND C 128) COARSE AGGREGATE SPECIFIC GRAVITY BULK	BULK SSD	APPARENT	PERCENT ABSORPTION	FINE AGGREGATE SPECIFIC GRAVITY BULK	BULK SSD	APPARENT	PERCENT ABSORPTION	ALKALI REACTIVITY (ASTM C 289) CA	FA	AGGREGATE USE
	2.63	2.65	2.67	0.60					Innocuous		Icr
											IIcr
13.91	2.67	2.69	2.73	0.77	2.53	2.55	2.65	1.75			Ic/f
											IIf/c
7.78					2.45	2.53	2.66	3.20		Deleterious	IIf
											IIcr
											IIcf
	2.62	2.63	2.65	0.43							Icr
	2.47	2.54	2.67	3.10					Deleterious	Potentially Deleterious	Ic IIf
											IIcr
	2.86	2.87	2.87	0.07					Innocuous		Icr
	2.62	2.65	2.72	1.52							Ic IIf
	2.33	2.37	2.43	1.85					Potentially Deleterious		Icr

FUGRO NATIONAL FIELD STATION
AND SUPPLEMENTARY TEST DATA
SNAKE VALLEY, NEVADA-UTAH

MX SITING INVESTIGATION
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TABLE A-1
PAGE 1 OF 5

FUGRO NATIONAL, INC.

MAP NUMBER	FIELD STATION	LOCATION	GEOLOGIC UNIT	MATERIAL DESCRIPTION	USCS SYMBOL	BOULDERS AND/OR COBBLES, PERCENT	DISTR... MATER... THAN...
							GRAVEL
14	SECDP-A14	Deep Creek Mountains	Gr	Granite			
15	SECDP-B1	Snake Valley	Aal	Gravelly Sand	SP	T	35
16	SECDP-B2	Snake Valley	Aol	Sandy Gravel	GP		
17	SECDP-B3	Snake Valley	Aol	Sandy Gravel	GP		
18	SECDP-B4	Snake Valley	Aolg	Sandy Gravel	GP		
19	SECDP-B5	Snake Valley	Aafs	Gravelly Sand	SP	5	45
20	SECDP-B6	Snake Valley	Do	Dolomite			
21	SECDP-B7	Snake Valley	Mu	Mica Schist			
22	SECDP-B8	Snake Valley	Aol	Sandy Gravel	GP		
23	SECDP-B9	Snake Valley	Aol	Sandy Gravel	GP	T	60
24	SECDP-B10	Snake Valley	Aol	Sandy Gravel	GW	5	55
25	SECDP-B11	Snake Valley	Do	Dolomite			
26	SECDP-B12	Snake Valley	Aaf	Sandy Gravel	GW	20	60

FIELD OBSERVATIONS						SIEVE ANALYSIS, PERCENT PASSING (ASTM C 136)									
IBUTION OF IAL FINER COBBLES, ERCENT		PLASTICITY	HARDNESS	WEATHERING	DELETERIOUS MATERIALS										
SAND	FINES					3"	1½"	¾"	⅜"	NO. 4	NO. 8	NO. 16	NO. 30	NO. 50	N 1
			Mod. Hard	Moderate	None										
65	T	None			Caliche Coatings, Mica										
		None			Caliche Coatings, Mica	97.7	85.9	69.8	48.1	20.4	13.2	9.9	7.3	6.3	
		None			Caliche Coatings, Mica	100	81.6	61.6	44.9	33.2	28.2	24.4	20.5	12.6	
		None			Caliche Coatings, <5% Chert	100	89.5	70.3	44.4	34.8	33.0	29.5	25.1	21.0	
50	T	None			Caliche Coatings										
			Hard	Slight	5 to 10% Chert										
			Hard	Slight	Mica Schist										
		None			Caliche Coatings, Mica, <5% Chert	94.5	79.0	64.4	51.5	37.8	24.5	21.6	20.6	14.6	
40	0	None			<5% Chert, Caliche Coatings, Mica										
45	0	None			<5% Chert, Caliche Coatings, Mica										
			Hard	Slight	None										
40	T	None			<5% Chert, Caliche Coatings										

LABORATORY TEST DATA

C 136)			ABRASION TEST (ASTM C 131)	SOUNDNESS TEST (ASTM C 88)		SPECIFIC GRAVITY AND ABSORPTION (ASTM C 127 AND C 128)								ALKALI REACTIVITY (ASTM C 289)	
						COARSE AGGREGATE				FINE AGGREGATE					
						SPECIFIC GRAVITY			PERCENT ABSORPTION	SPECIFIC GRAVITY			PERCENT ABSORPTION		
				PERCENT LOSS											
NO. 50	NO. 100	NO. 200	PERCENT WEAR	CA	FA	BULK	BULK SSD	APPARENT		BULK	BULK SSD	APPARENT		CA	FA
			47.1	8.10		2.61	2.63	2.66	0.72						
6.3	4.8	1.7	25.3	0.71		2.67	2.67	2.69	0.31						
12.6	4.8	1.5	23.6	0.45		2.60	2.61	2.63	0.						
21.0	5.9	1.3	22.8	0.22		2.64	2.66	2.70	0.87						
14.6	2.6	0.6			3.39					2.56	2.63	2.75	2.63	Innocuous	Innocuou

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S TEST (88) LOSS	SPECIFIC GRAVITY AND ABSORPTION (ASTM C 127 AND C 128)								ALKALI REACTIVITY (ASTM C 289)		AGGREGATE USE
	COARSE AGGREGATE				FINE AGGREGATE						
	SPECIFIC GRAVITY			PERCENT ABSORPTION	SPECIFIC GRAVITY			PERCENT ABSORPTION			
FA	BULK	BULK SSD	APPARENT		BULK	BULK SSD	APPARENT		CA	FA	
	2.61	2.63	2.66	0.72							Icr
											IIf/c
	2.67	2.67	2.69	0.31							Ic IIf
	2.60	2.61	2.63	0.44							Ic IIf
	2.64	2.66	2.70	0.87							Ic IIf
											IIf/c
											IIcr
											IIcr
3.39					2.56	2.63	2.75	2.63	Innocuous	Innocuous	IIc If
											IIc/f
											IIc/f
											IIcr
											IIc/f

FUGRO NATIONAL FIELD STATION
AND SUPPLEMENTARY TEST DATA
SNAKE VALLEY, NEVADA-UTAH

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE BMO

TABLE A-1

FUGRO NATIONAL, INC.

MAP NUMBER	FIELD STATION	LOCATION	GEOLOGIC UNIT	MATERIAL DESCRIPTION	USCS SYMBOL	BOULDERS AND/OR COBBLES, PERCENT	DISTRIBUT[ION OF] MATERIAL [FINER] THAN CO[BBLES,] PERCE[NT]	
							GRAVEL	SAND
27	SECDP-B13	Snake Valley	Aaf	Sandy Gravel	GP-GM	25	50	40
28	SECDP-B14	Snake Valley	Aols	Gravelly Sand	SP			
29	SECDP-B15	Snake Valley	Aol	Gravelly Sand	SW	0	10	90
30	SECDP-B16	Snake Valley	Aolg	Sandy Gravel	GP			
31	SECDP-B17	Snake Valley	Aolg	Sandy Gravel	GP			
32	SECDP-B18	Snake Valley	Aolg	Gravelly Sand	SP	T	30	70
33	SECDP-B19	Snake Valley	Aaf	Sandy Gravel	GW		55	45
34	SECDP-B20	Snake Valley	Acl	Sandy Gravel	GP			
35	SECDP-B21	Snake Valley	Aol	Gravelly Sand	SW	0	40	60
36	SECDP-B22	Ferguson Desert	Do	Dolomite				
37	SECDP-B23	Burbank Hills	Aafs	Gravelly Sand	SP-SM	T	35	55
38	SECDP-B24	Burbank Hills	Do	Dolomite				
39	SECDP-B25	Ferguson Desert	Aafs	Gravelly Sand	SP	5	35	65

FIELD OBSERVATIONS								SIEVE ANALYSIS, PERCENT PASSING (							
AND/OR COBBLES, PERCENT	DISTRIBUTION OF MATERIAL FINER THAN COBBLES, PERCENT			PLASTICITY	HARDNESS	WEATHERING	DELETERIOUS MATERIALS								
	GRAVEL	SAND	FINES					3"	1½"	¾"	⅜"	NO. 4	NO. 8	NO. 16	
25	50	40	10	Low			<5% Chert and Caliche and Clay Coatings								
				None			Caliche Coatings			100	99.4	90.1	59.6	20.3	
0	10	90	T	None			Caliche Coatings								
				None			<5% Vesicular Basalt	100	99	87.3	67.1	45.6	33.7	28.4	2
				None			<5% Chert, Caliche Coatings	100	92.3	81.6	78.5	54.2	32.0	15.1	
T	30	70	0	None			Caliche Coatings								
	55	45	5	None			Caliche Coatings, Mica								
				None			Caliche Coatings, <5% Chert	94.0	79.8	65.3	44.9	24.9	15.4	10.2	
0	40	60	0	None			Caliche Coatings, <5% Chert								
					Hard	Slight	None								
T	35	55	10	Low			Friable Materials, Caliche Coatings								
					Hard	Slight	<5% Chert								
5	35	65	T	None			<5% Chert, Caliche Coatings								

LABORATORY TEST DATA

ASSING (ASTM C 136)					ABRASION TEST (ASTM C 131)	SOUNDNESS TEST (ASTM C 88)		SPECIFIC GRAVITY AND ABSORPTION (ASTM C 127 AND C 128)								RE (AS
								COARSE AGGREGATE				FINE AGGREGATE				
								SPECIFIC GRAVITY			PERCENT ABSORPTION	SPECIFIC GRAVITY			PERCENT ABSORPTION	
NO. 16	NO. 30	NO. 50	NO. 100	NO. 200	PERCENT WEAR	PERCENT LOSS CA	PERCENT LOSS FA	BULK	BULK SSD	APPARENT		BULK	BULK SSD	APPARENT		CA
20.3	7.6	5.7	4.2	1.6			5.61					2.54	2.61	2.74	2.86	Innocuous
28.4	23.1	11.2	4.8	1.6	19.9	2.40	9.22	2.64	2.66	2.70	0.89	2.44	2.62	2.97	7.27	Deleteriou
15.1	7.3	6.1	4.9	1.4	23.6	3.10	6.70									
10.2	4.9	0.9	0.2	0.1	22.4	0.34		2.61	2.63	2.67	0.79					

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TEST DATA

ESS TEST C 88)	SPECIFIC GRAVITY AND ABSORPTION (ASTM C 127 AND C 128)								ALKALI REACTIVITY (ASTM C 289)		AGGREGATE USE
	COARSE AGGREGATE				FINE AGGREGATE						
NT LOSS	SPECIFIC GRAVITY			PERCENT ABSORPTION	SPECIFIC GRAVITY			PERCENT ABSORPTION			
FA	BULK	BULK SSD	APPARENT		BULK	BULK SSD	APPARENT		CA	FA	
											IIc/f
5.61					2.54	2.61	2.74	2.86	Innocuous	Innocuous	If IIc
											IIf
9.22	2.64	2.66	2.70	0.89	2.44	2.62	2.97	7.27	Deleterious		Ic/f
6.70											Ic/f
											IIf/c
											IIc/f
	2.61	2.63	2.67	0.79							Ic IIf
											IIf/c
											IIcr
											IIf/c
											IIcr
											IIf/c

FUGRO NATIONAL FIELD STATION
AND SUPPLEMENTARY TEST DATA
SNAKE VALLEY, NEVADA-UTAH

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE BMO

TABLE A-1

FUGRO NATIONAL, INC.

MAP NUMBER	FIELD STATION	LOCATION	GEOLOGIC UNIT	MATERIAL DESCRIPTION	USCS SYMBOL	BOULDERS AND/OR COBBLES, PERCENT	DISTRIBU[illegible] MATERIA[illegible] THAN C[illegible] PERC[illegible] GRAVEL	SAND
40	SECDP-B26	Snake Valley	Do	Dolomite				
41	SECDP-B27	Snake Valley	Ls	Limestone				
42	SECDP-B28	Snake Valley	Do	Dolomite				
43	SECDP-B30	Snake Valley	Ls	Limestone				
44	SECDP-B31	Snake Valley	Aaf	Gravelly Sand	SP-SM	5	40	50
45	UGS-A50	Pine Valley	Aals	Sandy Gravel	GP	T	70	30
46	UGS-A51	Ferguson Desert	Do	Dolomite				
47	UGS-A52	Crystal Peak	Vu	Ash Flow				
48	UGS-A59	Pine Valley	Aafs	Sandy Gravel	GP	5	65	3[illegible]
49	UGS-A90	Snake Valley	Aafs	Silty Sand	SP			
50	UGS-A93	Ferguson Desert	Aals	Sandy Gravel	GP	T	55	[illegible]
51	UGS-B12	Confusion Range	Ls	Limestone				
52	UGS-B13	West of Gandy	Aaf	Sandy Gravel	GP	5	65	3[illegible]

FIELD OBSERVATIONS							SIEVE ANALYSIS, PERCENT PASSING (ASTM							
DISTRIBUTION OF MATERIAL FINER THAN COBBLES, PERCENT			PLASTICITY	HARDNESS	WEATHERING	DELETERIOUS MATERIALS								
GRAVEL	SAND	FINES					3"	1½"	¾"	⅜"	NO. 4	NO. 8	NO. 16	NO. 30
				Hard	Slight	5 to 10% Chert								
				Hard	Slight	5 to 10% Chert								
				Hard	Slight	None								
				Hard	Slight	5 to 10% Chert								
40	50	10	Low			Caliche Coatings								
70	30	0	None			None								
				Hard	Slight	15 to 50% Chert								
				Soft	Slight	75% Volcanic Glass and Pumice								
65	30	5	None			None								
			Low			Caliche Coatings	100	91.6	86.4	78.8	67.7	51.4	29.5	9.6
55	45	0	None			None								
				Very Hard	Slight	None								
65	30	5	None			<5% Chert								

LABORATORY TEST DATA

(ASTM C 136)				ABRASION TEST (ASTM C 131)	SOUNDNESS TEST (ASTM C 88)		SPECIFIC GRAVITY AND ABSORPTION (ASTM C 127 AND C 128)								ALKALI REACTIVITY (ASTM C 289	
							COARSE AGGREGATE				FINE AGGREGATE					
							SPECIFIC GRAVITY			PERCENT ABSORPTION	SPECIFIC GRAVITY			PERCENT ABSORPTION		
					PERCENT LOSS											
NO. 30	NO. 50	NO. 100	NO. 200	PERCENT WEAR	CA	FA	BULK	BULK SSD	APPARENT		BULK	BULK SSD	APPARENT		CA	F
9.6	2.8	1.1	0.5			31.1										

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TEST DATA

...ESS TEST (...C 88) ...NT LOSS FA	SPECIFIC GRAVITY AND ABSORPTION (ASTM C 127 AND C 128) — COARSE AGGREGATE — SPECIFIC GRAVITY BULK	BULK SSD	APPARENT	PERCENT ABSORPTION	FINE AGGREGATE — SPECIFIC GRAVITY BULK	BULK SSD	APPARENT	PERCENT ABSORPTION	ALKALI REACTIVITY (ASTM C 289) CA	FA	AGGREGATE USE
											IIcr
											IIcr
											IIcr
											IIcr
											IIf/c
											IIc/f
											IIcr
											IIcr
											IIc/f
31.1											IIf/c
											IIc/f
											IIcr
											IIc/f

FUGRO NATIONAL FIELD STATION
AND SUPPLEMENTARY TEST DATA
SNAKE VALLEY, NEVADA-UTAH

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TABLE A-1
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FUGRO NATIONAL, INC.

MAP NUMBER	FIELD STATION	LOCATION	GEOLOGIC UNIT	MATERIAL DESCRIPTION	USCS SYMBOL	BOULDERS AND/OR COBBLES, PERCENT	DISTRIBUT MATERIAL THAN CO PERCE	
							GRAVEL	SAND
53	UGS-B14	Confusion Range	Su	Limestone				
54	UGS-B22	Deep Creek Range	Gr	Granite				
55	UGS-B23	Deep Creek Range	Gr	Granite				
56	UGS-B24	Deep Creek Range	Aaf	Sandy Gravel	GP	T	55	45
57	UGS-B71	Snake Valley	Cau	Limestone				
58	SET-2	Snake Valley	Aaf	Silty Gravelly Sand	SM			

FIELD OBSERVATIONS														
RIBUTION OF RIAL FINER N COBBLES, PERCENT		PLASTICITY	HARDNESS	WEATHERING	DELETERIOUS MATERIALS	SIEVE ANALYSIS, PERCENT PASSING (ASTM C 1								
SAND	FINES					3"	1½"	¾"	⅜"	NO. 4	NO. 8	NO. 16	NO. 30	NO. 50
			Hard	Slight	None									
			Hard	Slight	None									
			Mod. Hard	Moderate	None									
45	T	None			None									
			Hard	Slight	None									
							100	94.5	79	65	50*			43.5

LABORATORY TEST DATA

STM C 136)				ABRASION TEST (ASTM C 131)	SOUNDNESS TEST (ASTM C 88)		SPECIFIC GRAVITY AND ABSORPTION (ASTM C 127 AND C 128)								ALKALI REACTIVITY (ASTM C 289)	
							COARSE AGGREGATE				FINE AGGREGATE					
							SPECIFIC GRAVITY			PERCENT ABSORPTION	SPECIFIC GRAVITY			PERCENT ABSORPTION		
					PERCENT LOSS											
O.	NO. 50	NO. 100	NO. 200	PERCENT WEAR	CA	FA	BULK	BULK SSD	APPARENT		BULK	BULK SSD	APPARENT		CA	FA
				19	0.82											
	43.5*	36.5	30													

FUGRO NAT
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MX SITING I
DEPARTMENT OF THE

FUGRO

TEST DATA

...SS TEST (... C 88)	SPECIFIC GRAVITY AND ABSORPTION (ASTM C 127 AND C 128)								ALKALI REACTIVITY (ASTM C 289)		AGGREGATE USE
	COARSE AGGREGATE				FINE AGGREGATE						
	SPECIFIC GRAVITY			PERCENT ABSORPTION	SPECIFIC GRAVITY			PERCENT ABSORPTION			
...T LOSS FA	BULK	BULK SSD	APPARENT		BULK	BULK SSD	APPARENT		CA	FA	
											IIcr
											Icr
											IIcr
											IIc/f
											IIcr
											IIf/c

FUGRO NATIONAL FIELD STATION
AND SUPPLEMENTARY TEST DATA
SNAKE VALLEY, NEVADA-UTAH

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - BMO

TABLE
A-1

FUGRO NATIONAL, INC.

EXPLANATION OF EXISTING DATA

Existing data pertaining to aggregates were extracted from the Utah State Department of Highways' Materials Inventory county reports. These reports are compilations of avaiable site data from existing files and records and are intended to accurately locate, investigate, and catalog materials needed for highway construction. Explanations for column headings which appear in Table A-2, that have not been previously discussed in Table A-1, are given below:

Column Heading	Explanation
Site Number	Utah State Department of Highways pit or site number. Locations correspond to map numbers listed on this table and placed on Drawing 2.
Material Description USCS Symbol	To maintain conformity within the study, the Utah State Department of Highways classification system (A.A.S.H.O.) was converted to the Unified Soil Classification System (USCS) utilizing the sieve analyses' size distribution and the plasticity indices.
Sieve Analysis	The size distribution of fine and coarse aggregate samples was determined by sieving. In some samples, particles greater than 1 inch in size (>1 inch) were crushed to 1 inch maximum size and remixed with the remaining sample before sieving. In these cases, data entries under 1 inch are 100 percent, preceeded by before crushing percentages.
No. 8, No. 5	Samples tested before mid-1963 used No. 10 and No. 40 sieves, respectively. These entries are marked with asterisks.
Soundness Test	The testing of aggregates to determine their resistance to disintegration by saturated solutions of sodium sulfate. It furnishes information helpful in judging the soundness of aggregates subject to weathering action,

Column Heading	Explanation
Soundness Test (cont.)	particularly when adequate information is not available from service records of the material exposed to actual weathering conditions.

MAP NUMBER	SITE NUMBER	DATA SOURCE	LOCATION	GEOLOGIC UNIT	MATERIAL DESCRIPTION
59	14104	USDH Millard County	Little Valley	Aafs	Sandy Gravel
60	14105	USDH Millard County	S. Snake Valley	Aafs	Silty Gravelly Sand
61	14106	USDH Millard County	S. Snake Valley	Aafs	Sandy Gravel
62	14107	USDH Millard County	Central Snake Valley	Aolg	Sandy Gravel
63	14108	USDH Millard County	Central Snake Valley	Aols	
64	14109	USDH Millard County	Central Snake Valley	Aols	Sandy Gravel
65	14111	USDH Millard County	Central Snake Valley	Aolg	
66	14113	USDH Millard County	Central Snake Valley	Aols	Gravelly Sand
67	14121	USDH Millard County	S. Snake Valley	Aafs	Gravelly Sand
68	14122	USDH Millard County	S. Snake Valley	Aafs	Silty Sand
69	14123	USDH Millard County	S. Snake Valley	Aafs	Sandy Gravel
70	14124	USDH Millard County	S. Snake Valley	Aafs	Clayey Gravelly Sand
72	14125	USDH Millard County	S. Snake Valley	Aafs	Gravelly Sand

	USCS SYMBOL	SIEVE ANALYSIS: BEFORE CRUSHING, PERCENT		SIEVE ANALYSIS: PERCENT PASSING AFTER CRUSHING TO 1" MAXIMUM SIZE						ABRASION TEST (ASTM C 131)	SOUNDNESS TEST (ASTM C 88) PERCENT LOSS		PLASTICITY INDEX (ASTM D 423 and D 424)
		>3"	>1"	1"	½"	NO 4	NO 10	NO 40	NO 200	PERCENT WEAR	CA	FA	
	GP-GM			100		42.9	28.8	19.1	10.9				
nd	GM-SM			100		57.6	43.0	27.2	14.9				NP
	GM			100		50.3	37.0	27.0	13.7				
	GP	0	4.9	100	77.1	43.6	31.0*	12.6*	4.2	20.9	1.33	3.13	NP
	GP-GM		6.4	100		48.6	35.7	23.7	10.1	23.0			NP
	SP-SM	4.4	21.1	100		56.1	42.6	19.8	8.0	22.6			NP
	SP-SM	0	17.3	100		70.3	36.9	22.3	8.1	21.6			NP
	SM	0	6.6	93.4		61.1	42.0	29.3	16.3				NP
	GP-GM	0	16.4	100		45.4	29.1	14.8	5.8	25.8			1
nd	GC/SC	0	9.6	90.4		57.7	36.6	23.4	14.8				9
	SP	5.3	18.3	100		42.1	27.7	13.2	5.1	22.8			4

EXISTING TEST DATA
SNAKE VALLEY, NEVADA-UTAH

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - BMO

TABLE A-2
PAGE 1 OF 1

FUGRO NATIONAL, INC.

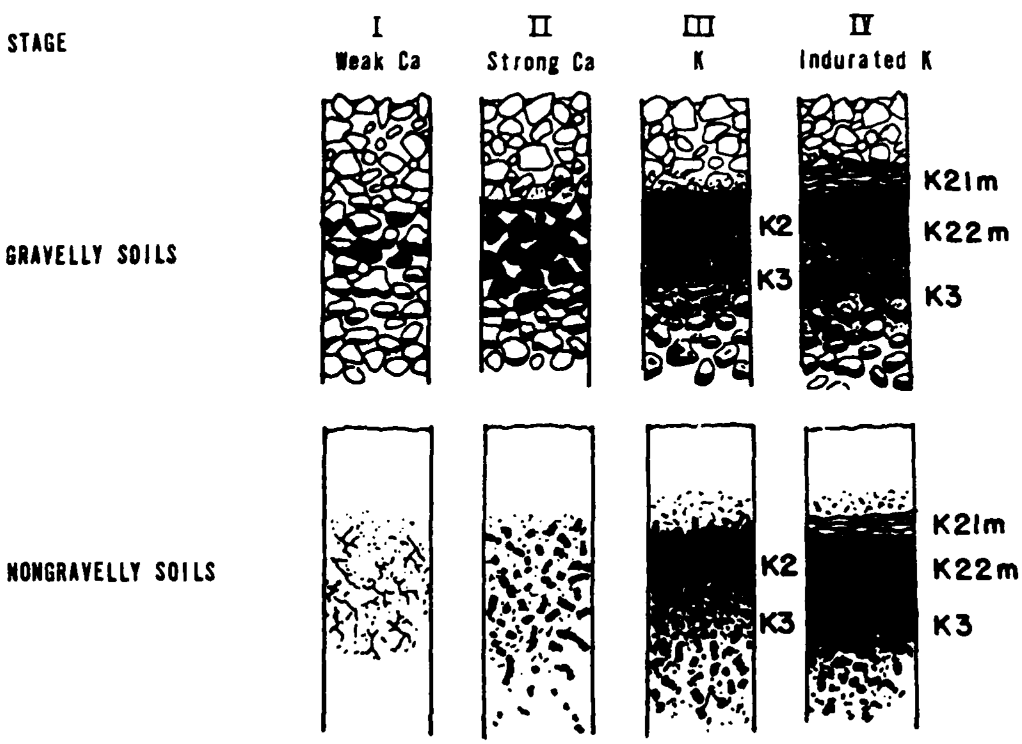
2

APPENDIX B

Summary of Caliche Development

DIAGNOSTIC CARBONATE MORPHOLOGY

STAGE	GRAVELLY SOILS	NONGRAVELLY SOILS
I	Thin, discontinuous pebble coatings	Few filaments or faint coatings
II	Continuous pebble coatings, some interpebble fillings	Few to abundant nodules, flakes, filaments
III	Many interpebble fillings	Many nodules and internodular fillings
IV	Laminar horizon overlying plugged horizon	Laminar horizon overlying plugged horizon



Stages of development of a caliche profile with time. Stage I represents incipient carbonate accumulation, followed by continuous build-up of carbonate until, in Stage IV, the soil is completely plugged.

Reference: Gile, L.H. Peterson, F.F., and Grossman, R.B., 1965. The K horizon: A master horizon of carbonate accumulation: Soil Science, v. 99, p. 74-82.

SUMMARY OF CALICHE DEVELOPMENT	
MX SITING INVESTIGATION DEPARTMENT OF THE AIR FORCE - BMO	FIGURE B-1
FUGRO NATIONAL, INC.	

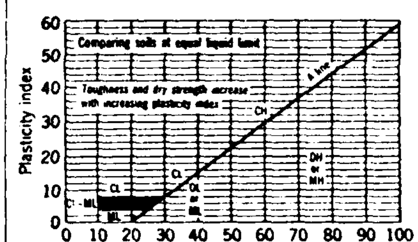
APPENDIX C

Unified Soil Classification System

Major Divisions			Field Identification Procedures (Excluding particles larger than 3 in. and basing fractions on estimated weights)	Group Symbols[a]	Typical Names	Information Required for Describing Soils	Laboratory Classification Criteria	
Coarse-grained soils: More than half of material is *larger* than No. 200 sieve size[b] (The No. 200 sieve size is about the smallest particle visible to naked eye)	Gravels: More than half of coarse fraction is *larger* than No. 4 sieve size (For visual classification, the ¼ in. size may be used as equivalent to the No. 4 sieve size)	Clean gravels (little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes	*GW*	Well graded gravels, gravel-sand mixtures, little or no fines	Give typical name; indicate approximate *percentages of sand* and gravel, maximum size; angularity, surface condition, and hardness of the coarse grains; local or geologic name and other pertinent descriptive information; and symbols in parentheses	$C_U = \frac{D_{60}}{D_{10}}$ Greater than 4; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3	
			Predominantly one size or a range of sizes with some intermediate sizes missing	*GP*	Poorly graded gravels, gravel-sand mixtures, little or no fines		Not meeting all gradation requirements for *GW*	
		Gravels with fines (appreciable amount of fines)	Nonplastic fines (for identification procedures see *ML* below)	*GM*	Silty gravels, poorly graded gravel-sand-silt mixtures		Atterberg limits below "A" line, or *PI* less than 4	Above "A" line with *PI* between 4 and 7 are *borderline* cases requiring use of dual symbols
			Plastic fines (for identification procedures, see *CL* below)	*GC*	Clayey gravels, poorly graded gravel-sand-clay *mixtures*	For undisturbed soils add information on stratification, degree of compactness, cementation, moisture conditions and *drainage characteristics*	Atterberg limits above "A" line, with *PI* greater than 7	
	Sands: More than half of coarse fraction is *smaller* than No. 4 sieve size	Clean sands (little or no fines)	Wide range in grain sizes and substantial amounts of all intermediate particle sizes	*SW*	Well graded sands, gravelly sands, little or no fines	Example: *Silty sand*, gravelly; about 20% hard, angular gravel particles ½-in. maximum size; rounded and subangular sand grains coarse to fine, about 15% non-plastic fines with low dry strength; well compacted and moist in place; alluvial sand; *(SM)*	$C_U = \frac{D_{60}}{D_{10}}$ Greater than 6; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3	
			Predominantly one size or a range of sizes with some intermediate sizes missing	*SP*	Poorly graded sands, gravelly sands, little or no fines		Not meeting all gradation requirements for *SW*	
		Sands with fines (appreciable amount of fines)	Nonplastic fines (for identification procedures, see *ML* below)	*SM*	Silty sands, poorly graded sand-silt mixtures		Atterberg limits below "A" line or *PI* less than 5	Above "A" line with *PI* between 4 and 7 are *borderline* cases requiring use of *dual symbols*
			Plastic fines (for identification procedures, see *CL* below)	*SC*	Clayey sands, poorly graded sand-clay mixtures		Atterberg limits below "A" line with *PI* greater than 7	

(Laboratory classification of coarse-grained soils:) Use grain size curve in identifying the fractions as given under field identification. Determine percentages of gravel and sand from grain size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size) coarse grained soils are classified as follows: Less than 5% *GW, GP, SW, SP*; More than 12% *GM, GC, SM, SC*; 5% to 12% *Borderline* cases requiring use of dual symbols

Major Divisions		Identification Procedures on Fraction Smaller than No. 40 Sieve Size: Dry Strength (crushing characteristics)	Dilatancy (reaction to shaking)	Toughness (consistency near plastic limit)	Group Symbols[a]	Typical Names	Information Required for Describing Soils
Fine-grained soils: More than half of material is *smaller* than No. 200 sieve size (The No. 200 sieve size is about the smallest particle visible to naked eye)	Silts and clays liquid limit less than 50	None to slight	Quick to slow	None	*ML*	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity	Give typical name; indicate degree and character of plasticity, amount and maximum size of coarse grains; colour in wet condition, odour if any, local or geologic name, and other pertinent descriptive information, and symbol in parentheses
		Medium to high	None to very slow	Medium	*CL*	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	
		Slight to medium	Slow	Slight	*OL*	Organic silts and organic silt-clays of low plasticity	For undisturbed soils add information on structure, stratification, consistency in undisturbed and remoulded states, moisture and drainage conditions
	Silts and clays liquid limit greater than 50	Slight to medium	Slow to none	Slight to medium	*MH*	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts	
		High to very high	None	High	*CH*	Inorganic clays of high plasticity, fat clays	Example: *Clayey silt*, brown; slightly plastic; small percentage of fine sand; numerous vertical root holes; firm and dry in place; loess; *(ML)*
		Medium to high	None to very slow	Slight to medium	*OH*	Organic clays of medium to high plasticity	
Highly Organic Soils		Readily identified by colour, odour, spongy feel and frequently by fibrous texture			*Pt*	Peat and other highly organic soils	



Plasticity chart
for laboratory classification of fine grained soils

From Wagner, 1957.
[a] *Boundary classifications.* Soils possessing characteristics of two groups are designated by combinations of group symbols. For example *GW-GC*, well graded gravel-sand mixture with clay binder.
[b] All sieve sizes on this chart are U.S. standard.

Field Identification Procedure for Fine Grained Soils or Fractions

These procedures are to be performed on the minus No. 40 sieve size particles, approximately $\frac{1}{64}$ in. For field classification purposes, screening is not intended, simply remove by hand the coarse particles that interfere with the tests.

Dilatancy (Reaction to shaking):
After removing particles larger than No. 40 sieve size, prepare a pat of moist soil with a volume of about one-half cubic inch. Add enough water if necessary to make the soil soft but not sticky.
Place the pat in the open palm of one hand and shake horizontally, striking vigorously against the other hand several times. A positive reaction consists of the appearance of water on the surface of the pat which changes to a livery consistency and becomes glossy. When the sample is squeezed between the fingers, the water and gloss disappear from the surface, the pat stiffens and finally it cracks or crumbles. The rapidity of appearance of water during shaking and of its disappearance during squeezing assist in identifying the character of the fines in a soil.
Very fine clean sands give the quickest and most distinct reaction whereas a plastic clay has no reaction. Inorganic silts, such as a typical rock flour, show a moderately quick reaction.

Dry Strength (Crushing characteristics):
After removing particles larger than No. 40 sieve size, mould a pat of soil to the consistency of putty, adding water if necessary. Allow the pat to dry completely by oven, sun or air drying, and then test its strength by breaking and crumbling between the fingers. This strength is a measure of the character and quantity of the colloidal fraction contained in the soil. The dry strength increases with increasing plasticity.
High dry strength is characteristic for clays of the CH group. A typical inorganic silt possesses only very slight dry strength. Silty fine sands and silts have about the same slight dry strength, but can be distinguished by the feel when powdering the dried specimen. Fine sand feels gritty whereas a typical silt has the smooth feel of flour.

Toughness (Consistency near plastic limit):
After removing particles larger than the No. 40 sieve size, a specimen of soil about one-half inch cube in size, is moulded to the consistency of putty. If too dry, water must be added and if sticky, the specimen should be spread out in a thin layer and allowed to lose some moisture by evaporation. Then the specimen is rolled out by hand on a smooth surface or between the palms into a thread about one-eighth inch in diameter. The thread is then folded and re-rolled repeatedly. During this manipulation the moisture content is gradually reduced and the specimen stiffens, finally loses its plasticity, and crumbles when the plastic limit is reached.
After the thread crumbles, the pieces should be lumped together and a slight kneading action continued until the lump crumbles.
The tougher the thread near the plastic limit and the stiffer the lump when it finally crumbles, the more potent is the colloidal clay fraction in the soil. Weakness of the thread at the plastic limit and quick loss of coherence of the lump below the plastic limit indicate either inorganic clay of low plasticity, or materials such as kaolin-type clays and organic clays which occur below the A-line.
Highly organic clays have a very weak and spongy feel at the plastic limit.

UNIFIED SOIL CLASSIFICATION SYSTEM

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - [illegible]

TABLE C-1

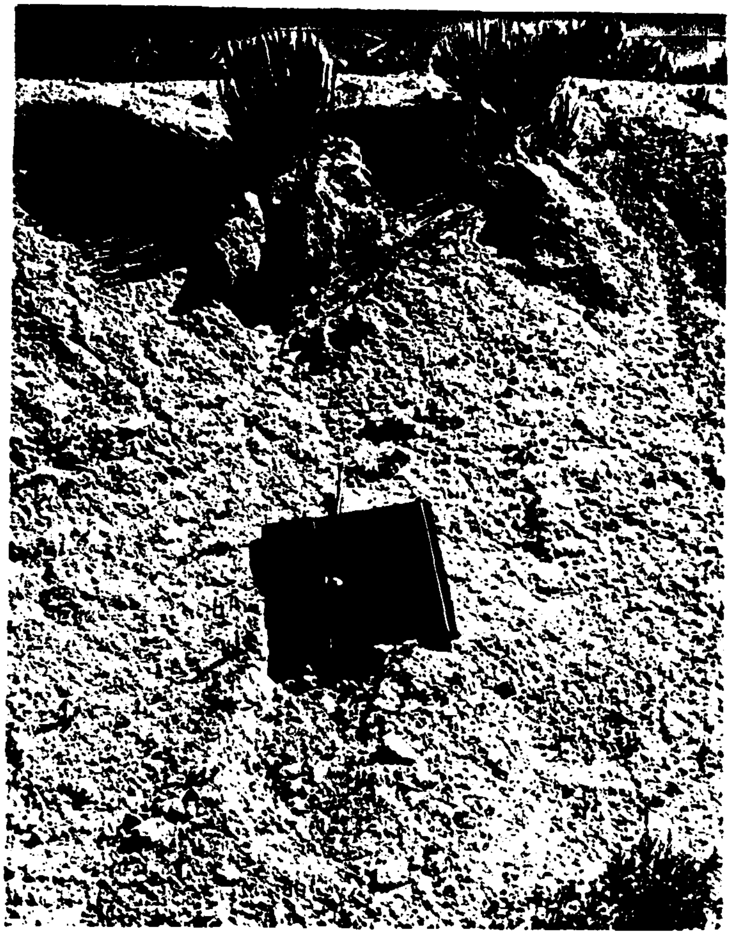
FUGRO NATIONAL, INC.

APPENDIX D

Snake Valley
Study Area Photographs

Older lacustrine deposits (Aol) west of Granite Mountain, Class I fine and coarse aggregate - multiple source (Field Station 31).

SNAKE VALLEY, NEVADA-UTAH STUDY AREA PHOTOGRAPH	
MX SITING INVESTIGATION DEPARTMENT OF THE AIR FORCE - BMO	FIGURE D-1
FUGRO NATIONAL, INC.	



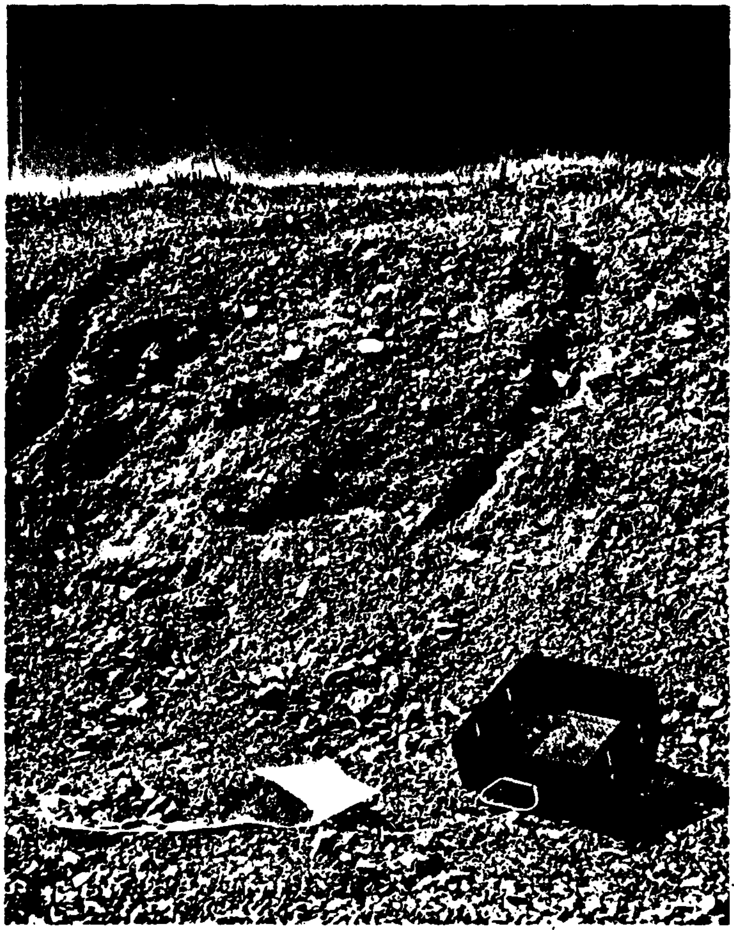
Older lacustrine deposit (Aol) east of Deep Creek Mountains, Class I fine aggregate source (Field Station 28).

SNAKE VALLEY, NEVADA-UTAH
STUDY AREA PHOTOGRAPH

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - BMO

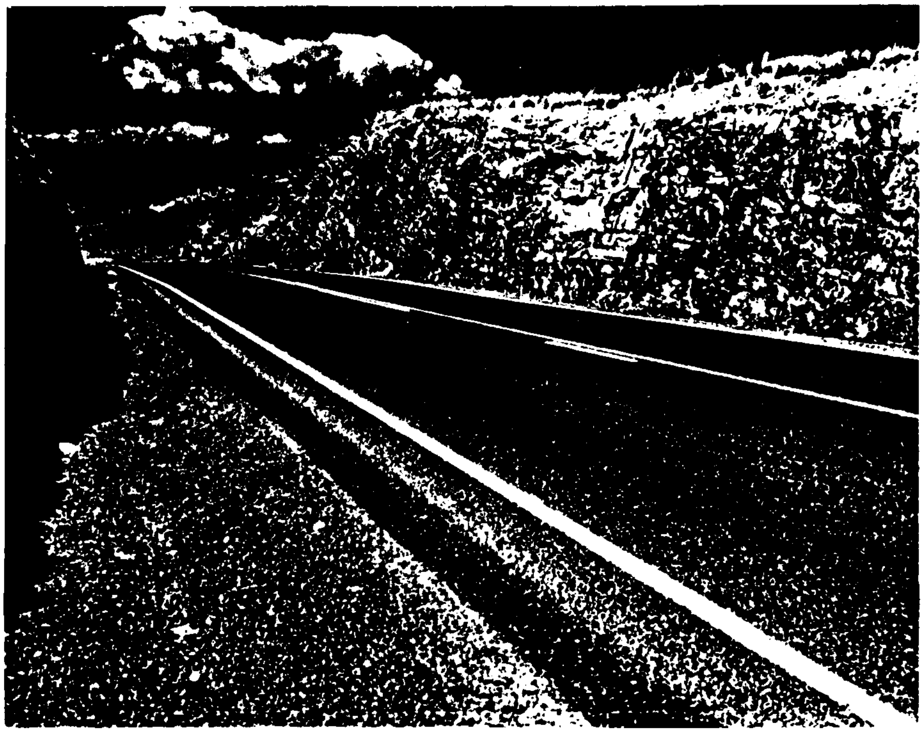
FIGURE D-2

FUGRO NATIONAL, INC.



Borrow pit located in an Alluvial Fan Deposit (Aafs) west of the Conger Range, Class I fine and coarse aggregate (multiple source); (Field Station 3).

SNAKE VALLEY, NEVADA-UTAH STUDY AREA PHOTOGRAPH	
MX SITING INVESTIGATION DEPARTMENT OF THE AIR FORCE - BMO	FIGURE D-3
FUGRO NATIONAL, INC.	



Dolomite of the Guilmette Formation (Cau), exposed in a road cut (U.S. Highway 6) in the Conger Range. Class I crushed rock aggregate source (Field Station 1).

SNAKE VALLEY, NEVADA-UTAH
STUDY AREA PHOTOGRAPH

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FIGURE D-4

FUGRO NATIONAL, INC.

Laketown Dolomite (Do) exposed at the southern end of the Confusion Range, Class I crushed rock aggregate source (Field Station 11).

SNAKE VALLEY, NEVADA-UTAH
STUDY AREA PHOTOGRAPH

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FIGURE
D-5

FUGRO NATIONAL, INC.

Exposure of Eureka Quartzite (Qtz) surrounded by carbonates in Southern Confusion Range, Class I crushed rock aggregate source (Field Station 8).

SNAKE VALLEY, NEVADA-UTAH
STUDY AREA PHOTOGRAPH

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FIGU[illegible]
D-[illegible]

FUGRO NATIONAL, INC

APPENDIX E

Fugro National Geologic Unit Cross Reference

AD-A112 774 FUGRO NATIONAL INC LONG BEACH CA F/G 8/7
MX SITING INVESTIGATION. AGGREGATE RESOURCES STUDY, SNAKE VALLE--ETC(U)
JUN 80 F04704-80-C-0006
UNCLASSIFIED FN-TR-37-B NL

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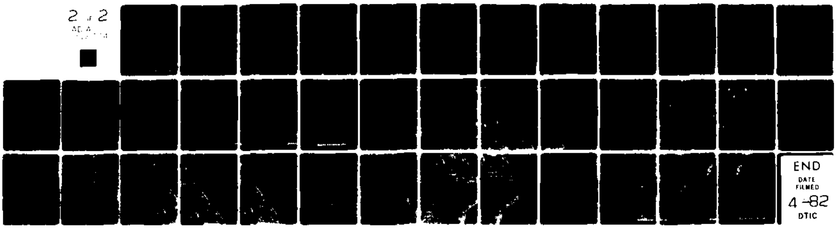
112774



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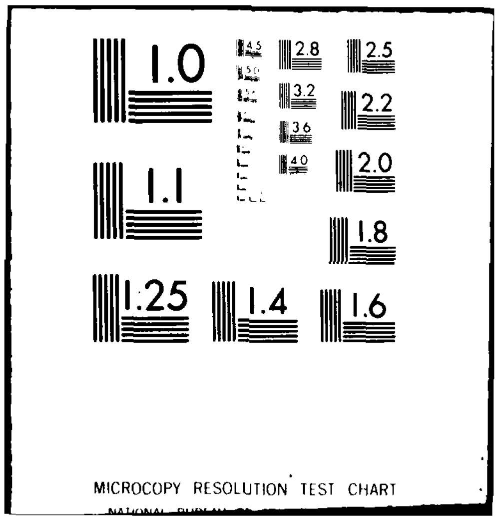
1.0
2.8
2.5
3.2
2.2
3.6
4.0
2.0
1.1
1.8
1.25
1.4
1.6
MICROCOPY RESOLUTION TEST CHART

UARSA POTENTIAL AGGREGATE SOURCE SYMBOLS	FUGRO NATIONAL GENERAL GEOLOGIC UNIT EXPLANATION	
		ROCK
		Shown in regions where rock is exposed, the areally predominant (greater than 70 percent) rock type is indicated. In those areas where two rock types occur the predominant rock type is shown followed by the subordinate rock type (e.g., $S_2/_{gr}$, I_4, ...). Rock may be subdivided into bedrock (B).
	I	IGNEOUS (UNDIFFERENTIATED) - Rocks formed by solidification of a molten or partially molten mass.
Gr	I_1	Intrusive (Plutonic) - Rocks formed by solidification of molten material beneath the surface (e.g., granite, granodiorite, diorite, gabbro).
Vu	I_2	Extrusive (intermediate and acidic) - Volcanic rocks of intermediate and acidic composition formed by solidification of molten material at or near the surface (e.g., rhyolite, latite, dacite, andesite).
Vb	I_3	Extrusive (basic) - Volcanic rocks of basic composition, generally formed by solidification of molten materials at or near the surface (e.g., basalt).
Vu	I_4	Extrusive (pyroclastic) - Rocks formed by accumulation of volcanic ejecta (e.g., ash, tuff, welded tuff, agglomerate).
Su	S	SEDIMENTARY (UNDIFFERENTIATED) - Rocks formed by accumulation of clastic solids, organic solids and/or chemically precipitated minerals.
Su, QTz	S_1	Arenaceous and/or Siliceous Rocks - Composed of sand size particles (e.g., sandstone, orthoquartzite) or of cryptocrystalline silica (e.g., opal, chert).
Ls, Do, Cau	S_2	Carbonate Rocks - Composed predominantly of calcium carbonate detritus or chemical precipitates (e.g., limestone, dolomite, chalk).
	S_3	Argillaceous Rocks - Composed of clay and silt sized particles (e.g., siltstone, shale, claystone).
	S_4	Evaporite Rocks - Precipitated from solution as a result of evaporation (e.g., halite, gypsum, anhydrite, sylvite).
Su	S_5	Coarse Clastic Rocks - Composed of gravel sized or larger clasts (e.g., conglomerate, breccia).
Mu	M	METAMORPHIC (UNDIFFERENTIATED) - Rocks formed through recrystallization in the solid state of preexisting rocks by heat and pressure.
Mu	M_1	Coarse grained - rocks formed by higher-grade regional metamorphism, either banded or granular (e.g., gneiss, granulite, amphibolite).
Mu	M_2	Fine grained - schistose rocks formed by lower grade regional metamorphism (e.g., schist, slate, phyllite).
Mu	M_3	Nonfoliated - rocks formed chiefly by contact metamorphism (e.g., hornfels, marble).
QTz	M_4	Metaquartzite - rocks formed by metamorphism of highly siliceous rock.
		BASIN-FILL
	A	BASIN-FILL DEPOSITS - Fine- to coarse-grained materials deposited principally by wind, water or gravity.
Aal	A_1	Younger Fluvial Deposits - Major modern stream channel and flood-plain deposits.
Au, Aal	A_2	Older Fluvial Deposits - Older incised stream channel and flood-plain deposits in elevated terraces bordering major modern drainages.
Au	A_3	Eolian Deposits - Wind-blown deposits of sand occurring as either thin sheets (A_{3s}) or dunes (A_{3d}).
Aol	A_4	Playa and Lacustrine Deposits - Deposits occurring in modern, active playas (A_4) or in either inactive playas or older lake beds and abandoned shorelines associated with extinct lakes (A_{4o}).
Aaf	A_5	Alluvial Fan Deposits - Alluvial deposits consisting of debris flow and water-laid alluvium near mountain fronts, grading into predominantly water-laid alluvium deposited in shifting distributary channels near the basin center. Younger (A_{5y}), intermediate (A_{5i}), and older (A_{5o}) alluvial fans are differentiated by surface soil development, terrain conditions and present depositional/erosional environment.
Au	A_3/A_5	Mixed non-rock units - Most areally extensive unit is listed first.
Aaf	A_{5y} (A_5)	Parenthetic unit underlies thin veneer of overlying mapped unit.

FUGRO NATIONAL GEOLOGIC UNIT CROSS REFERENCE

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DEPARTMENT OF THE AIR FORCE BMO

FIGURE
E-1

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6 JUN 80

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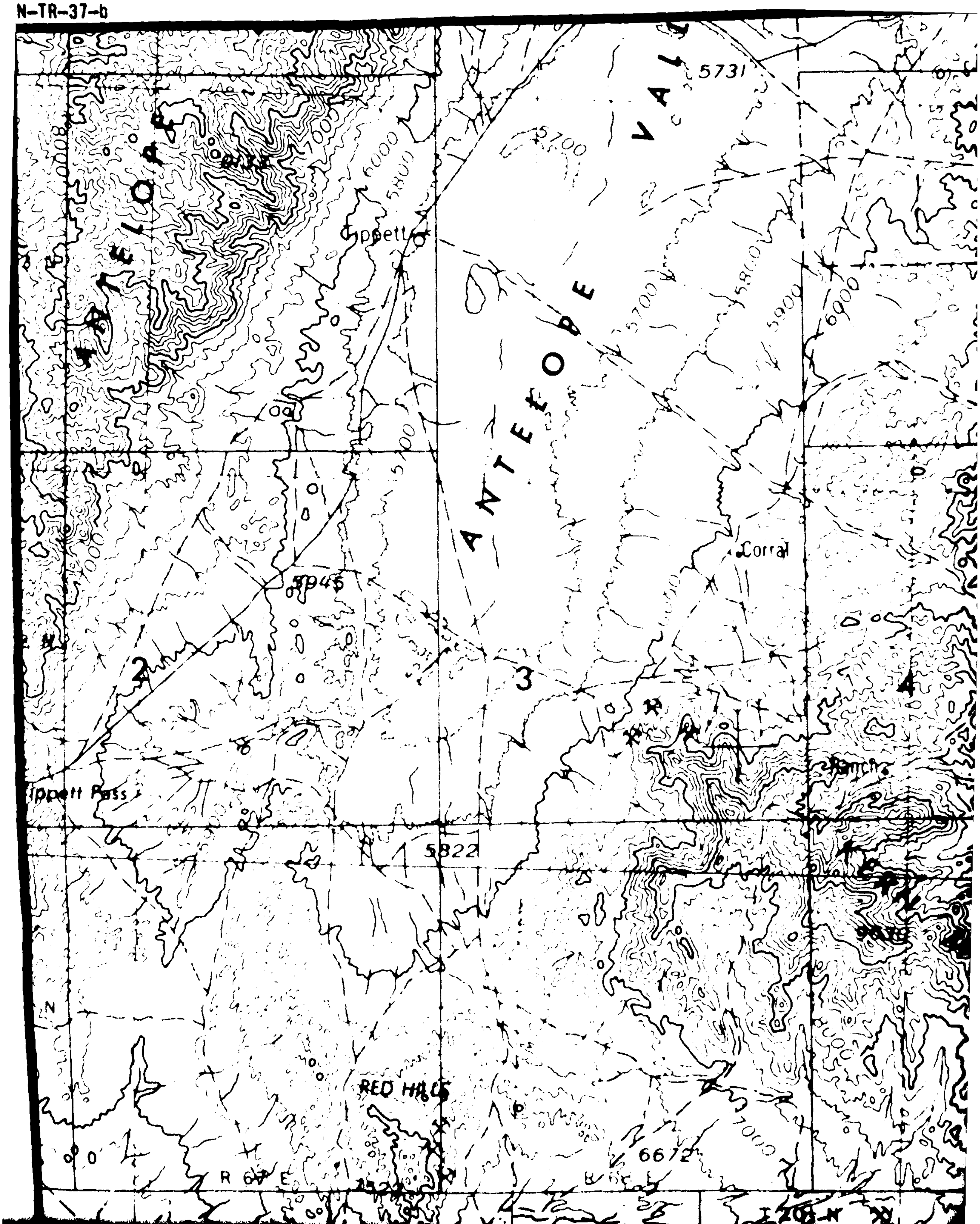
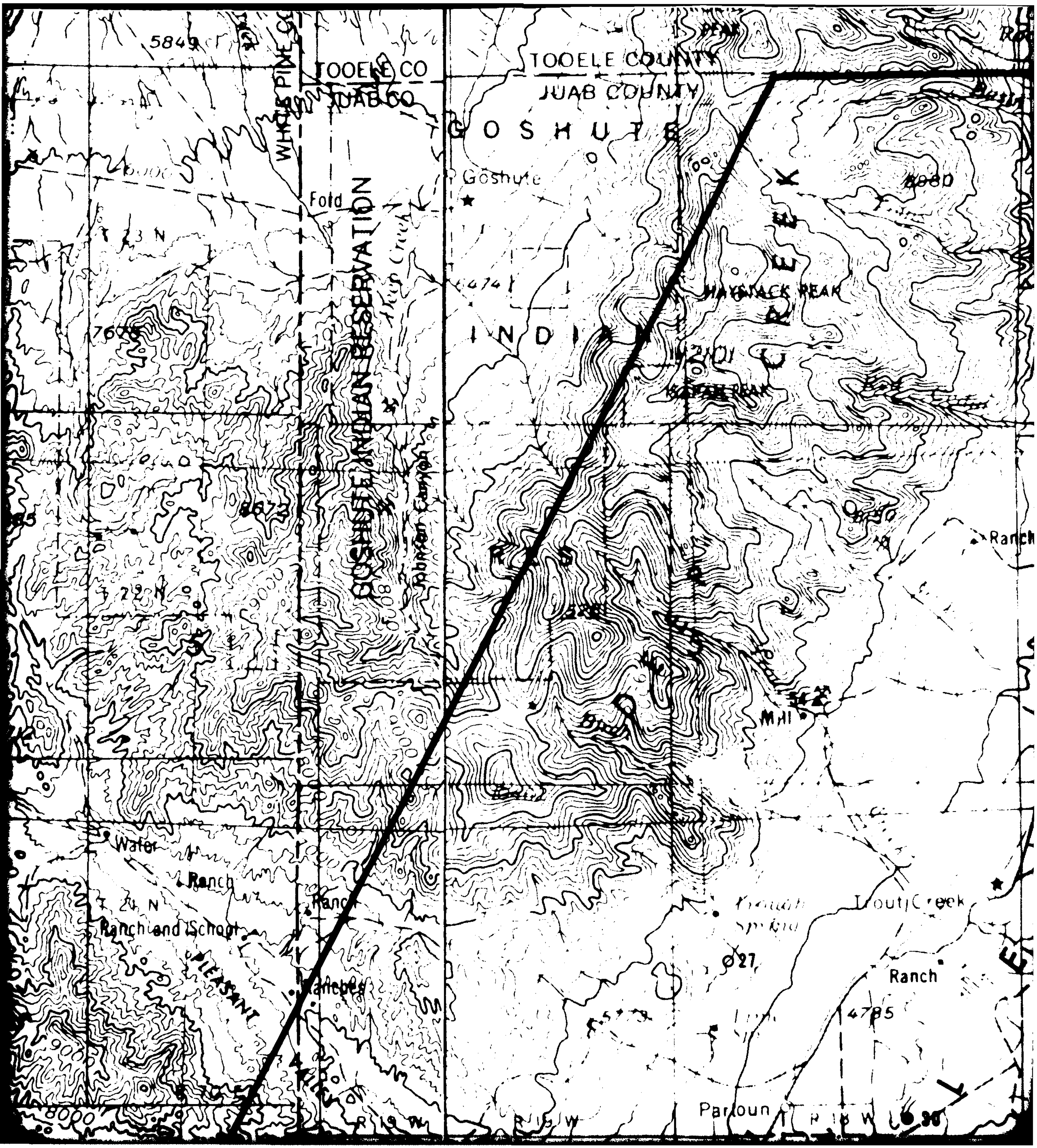
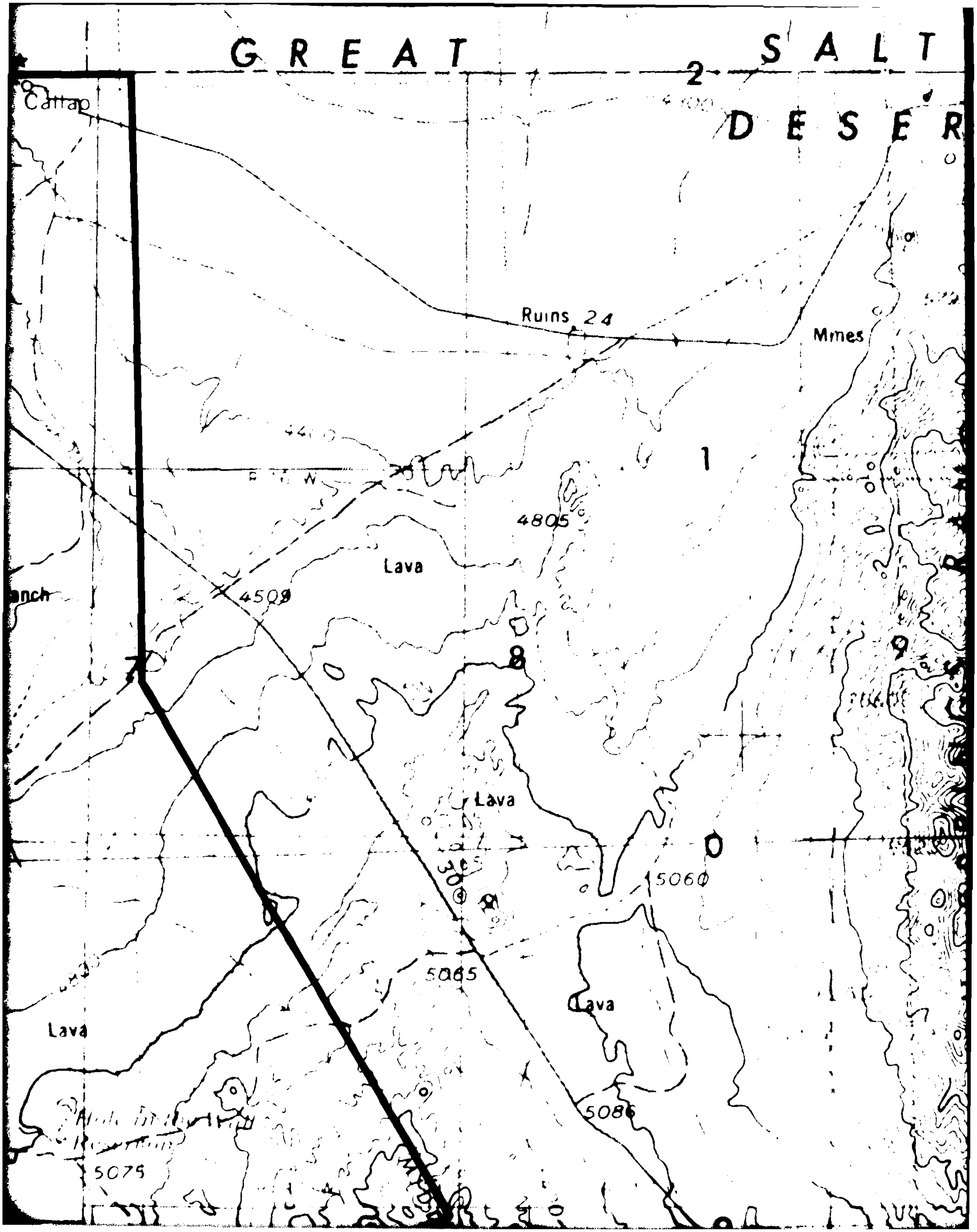
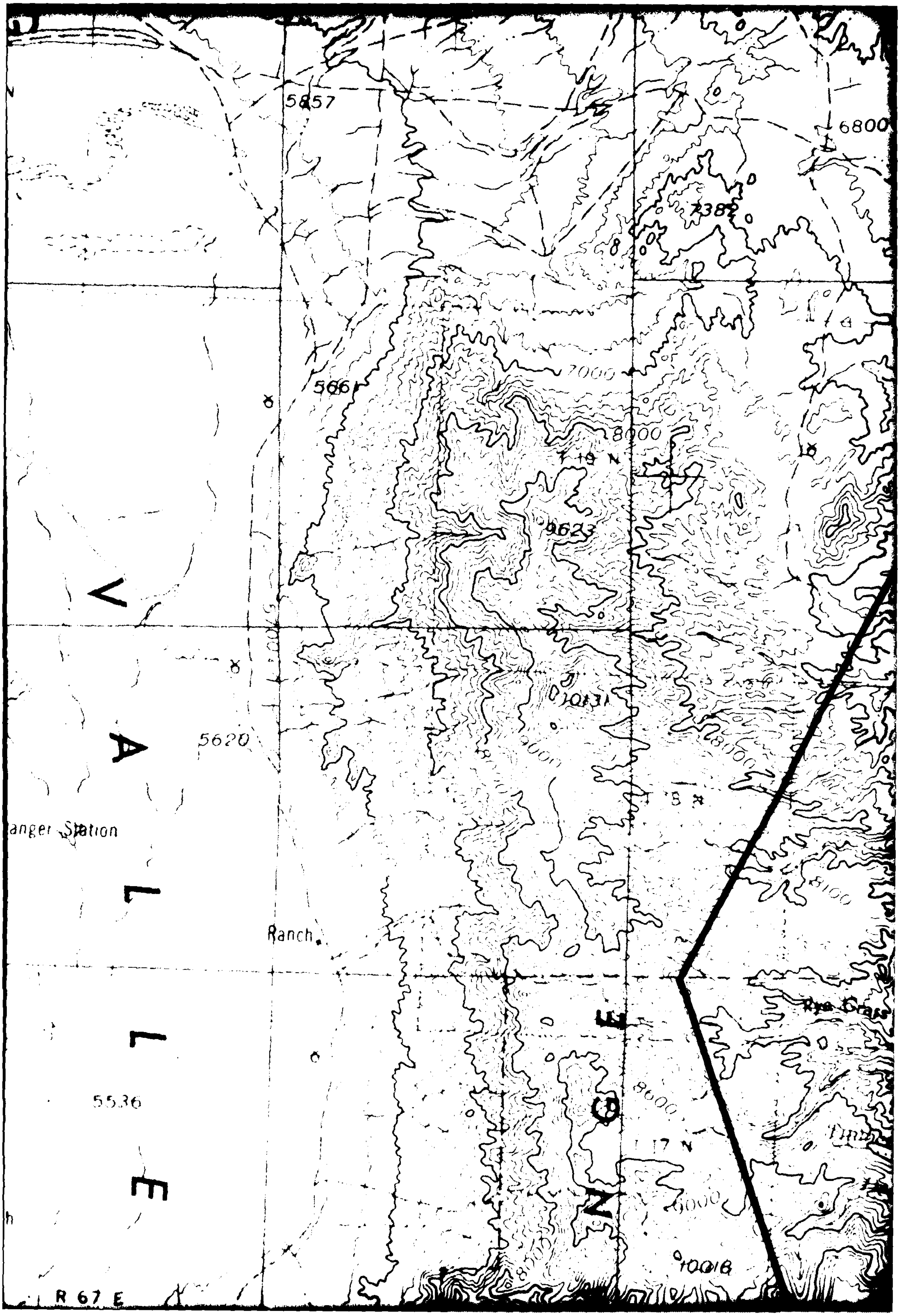
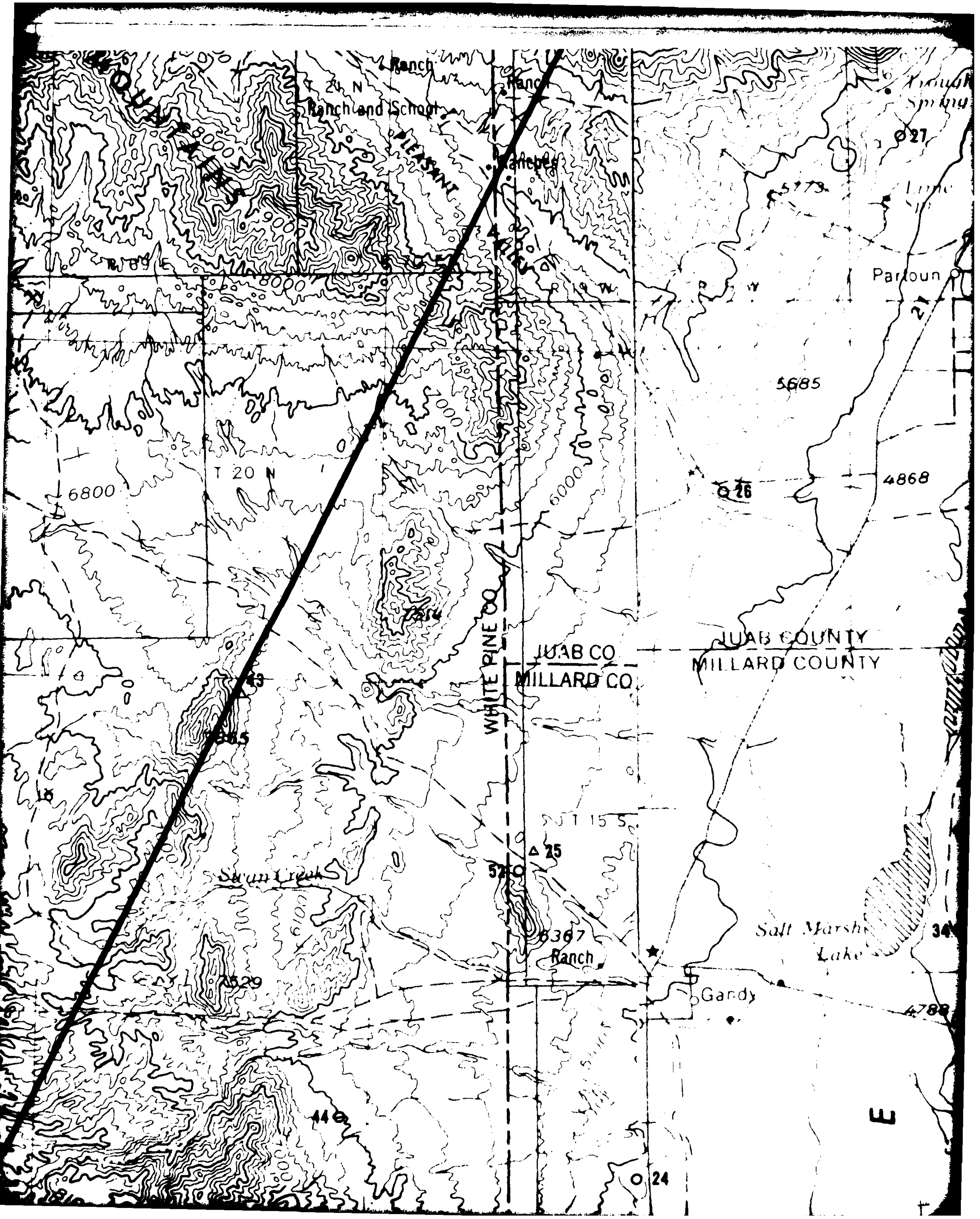

ANTELOPE
ANTELOPE VAL
5731
5700
6000
5800
7000
Tippett
5700
5800
5900
6000
5945
5700
Corral
2
3
4
Ranch
Tippett Pass
5822
RED HILLS
6672
7000
R 67 E
R 68 E
T 20 N



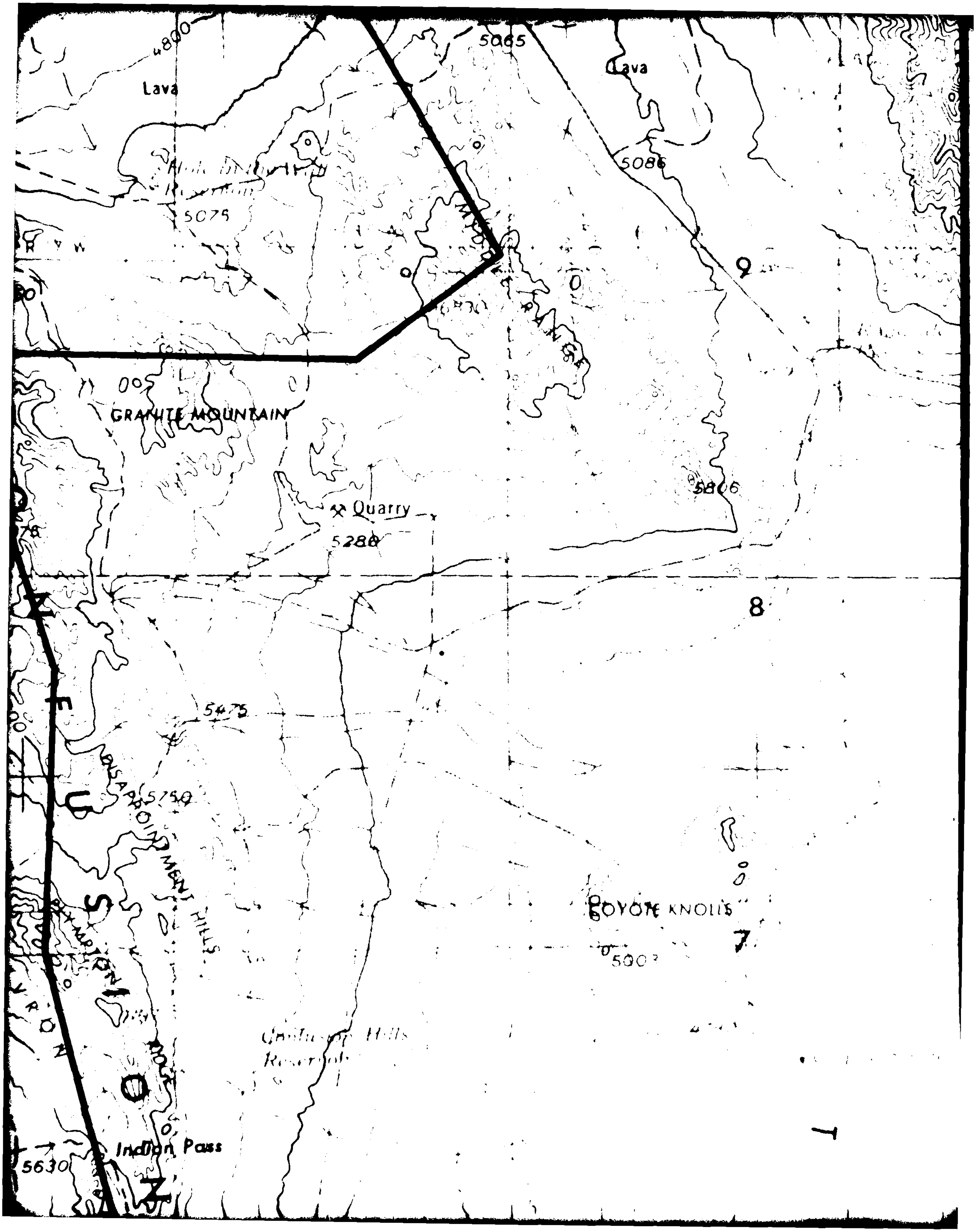
TOOELE COUNTY
JUAB COUNTY
TOOELE CO
JUAB CO
GOSHUTE
Goshute
Fold
GOSHUTE INDIAN RESERVATION
INDIAN
HAYSTACK PEAK
Johnson Canyon
Mill
Water
Ranch
Ranch and School
PLEASANT
Ranches
Trout Creek
Partoun
5849
7626
8673
4785


GREAT SALT
DESER
Callao
Ruins 24
Mines
1
4805
Lava
anch
4509
8
9
Lava
0
5060
5065
Lava
Lava
5086
5075

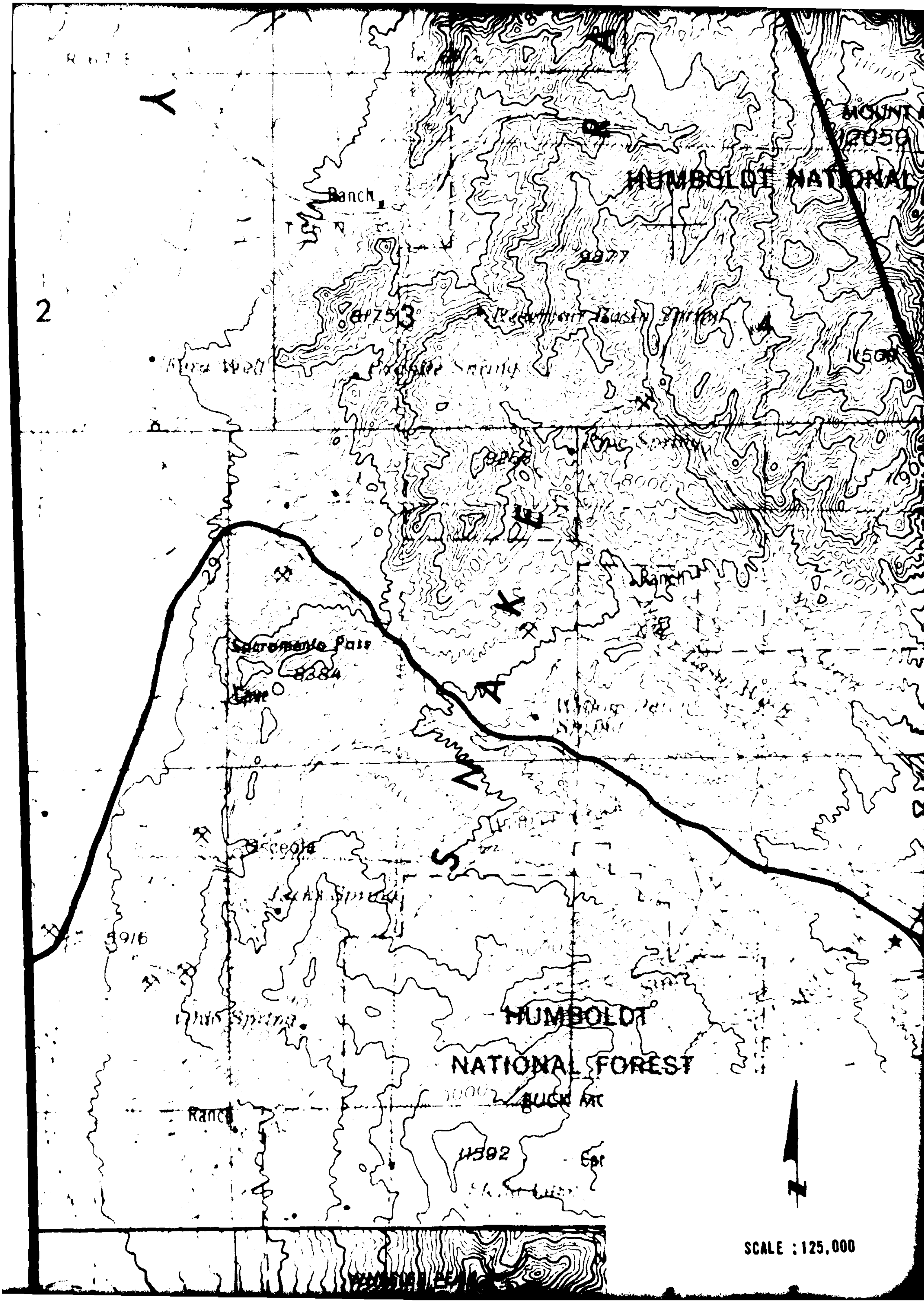

5857
6800
7382
5661
7000
8000
T 19 N
9623
10131
5620
T 18 N
anger Station
Ranch
8100
Rye Grass
5536
8600
T 17 N
10018
R 67 E
V A L L E

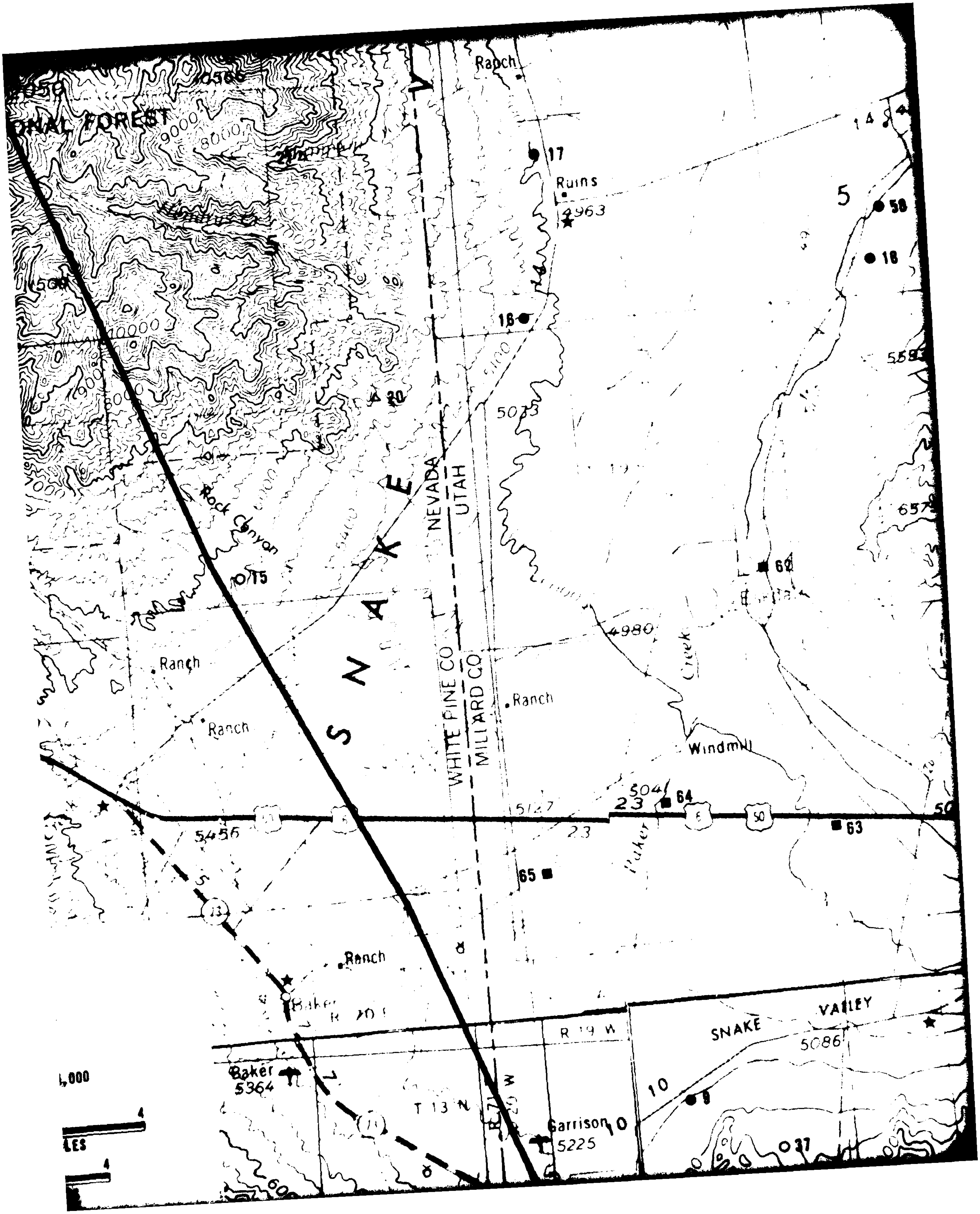


Ranch
T 20 N
Ranch and School
PLEASANT
Ranches
R 19 W
Partoun
21
5685
6800
T 20 N
7000
6000
O 26
4868
7514
WHITE PINE CO
JUAB CO
MILLARD CO
JUAB COUNTY
MILLARD COUNTY
T 15 S
△ 25
6367
Ranch
Salt Marsh
Lake
Gandy
4788
7529
44
O 24
O 27

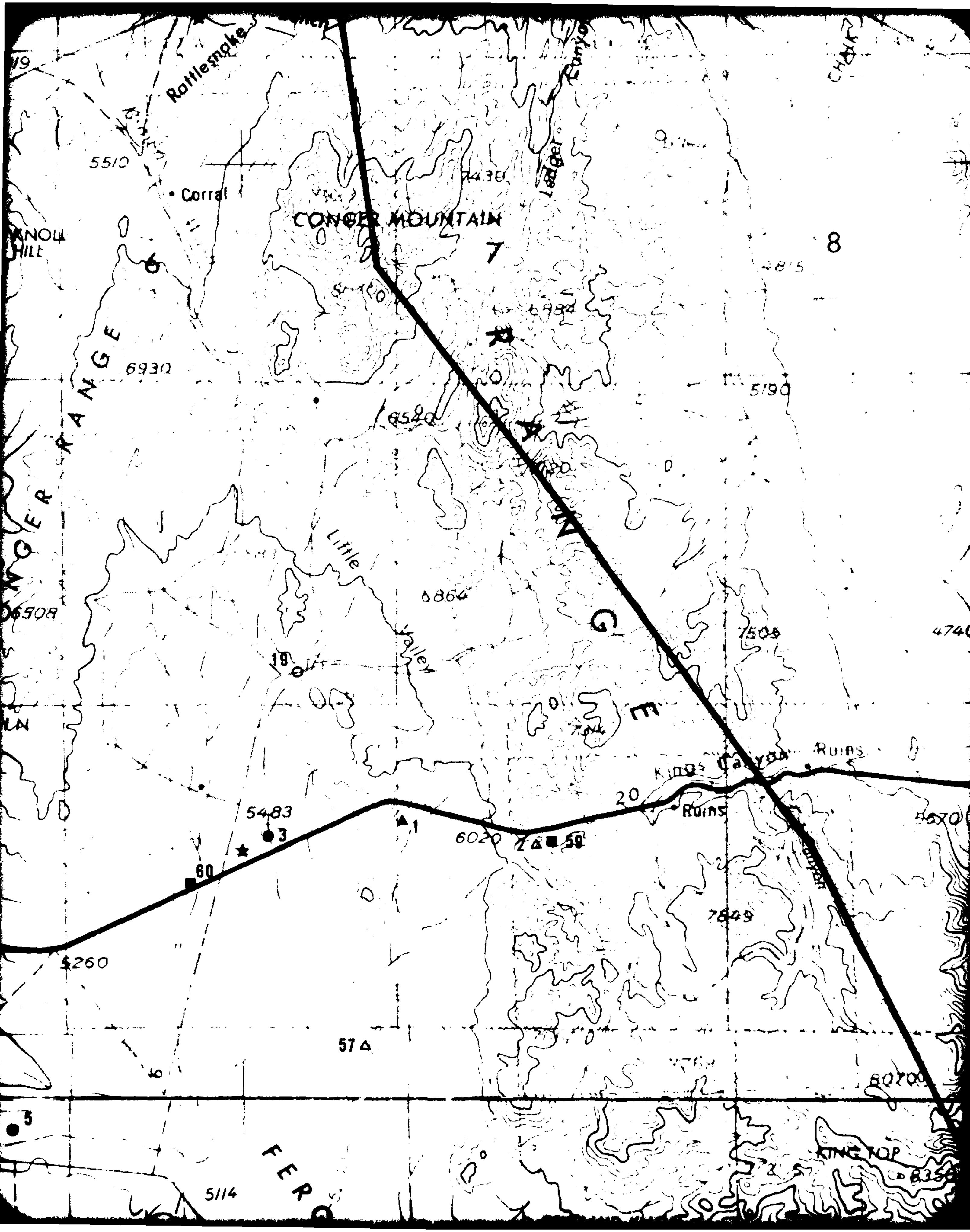


4800
Lava
5065
Lava
5086
5075
9
GRANITE MOUNTAIN
Quarry
5288
5806
8
5475
5750
DISAPPOINTMENT HILLS
COYOTE KNOLLS
7
5003
Indian Pass
5630

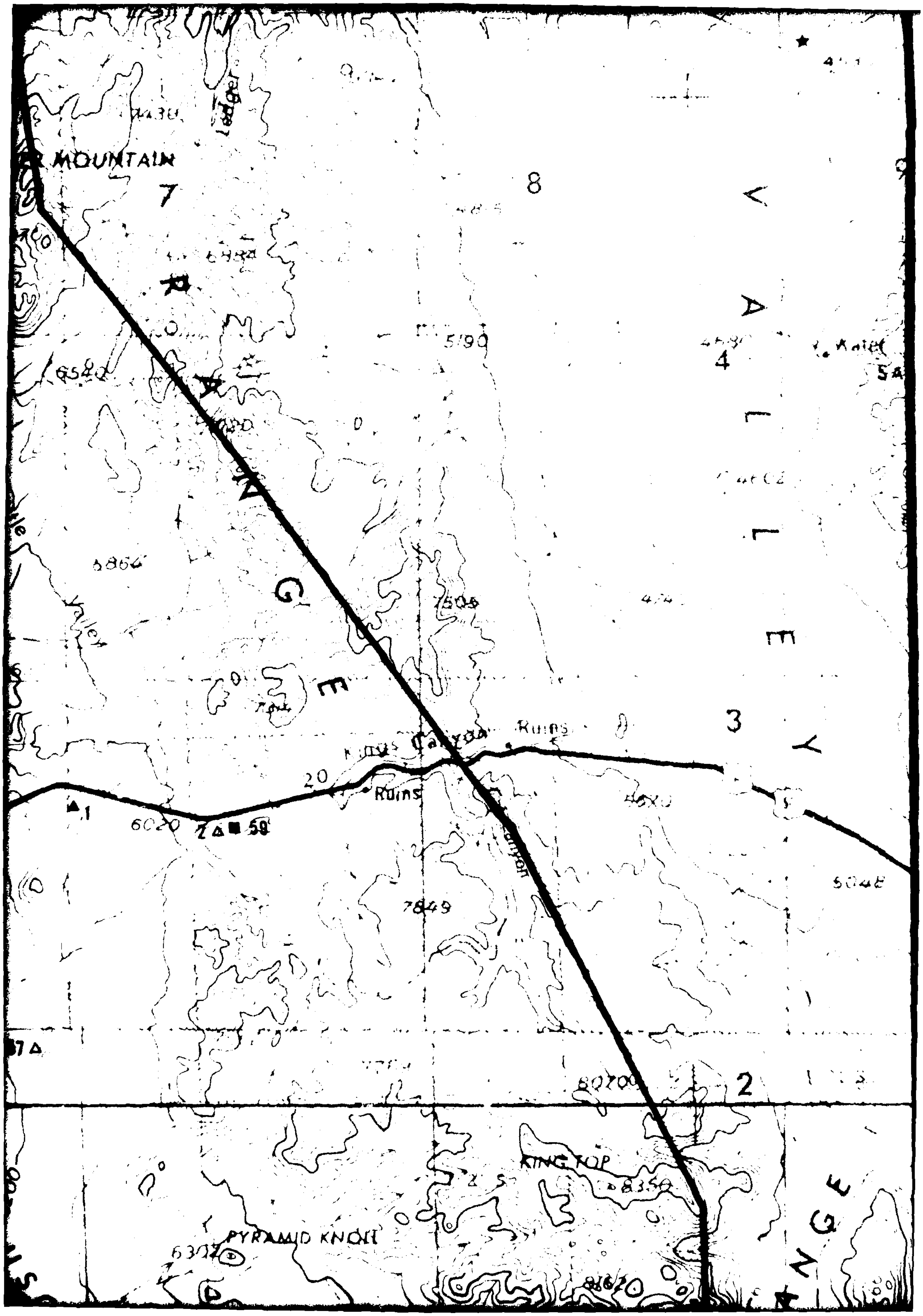

2
3
4
MOUNT
12050
HUMBOLDT NATIONAL
Ranch
9377
8753
11509
Sacramento Pass
8284
Cave
Osceola
5916
HUMBOLDT
NATIONAL FOREST
11592
Ranch
SCALE : 125,000

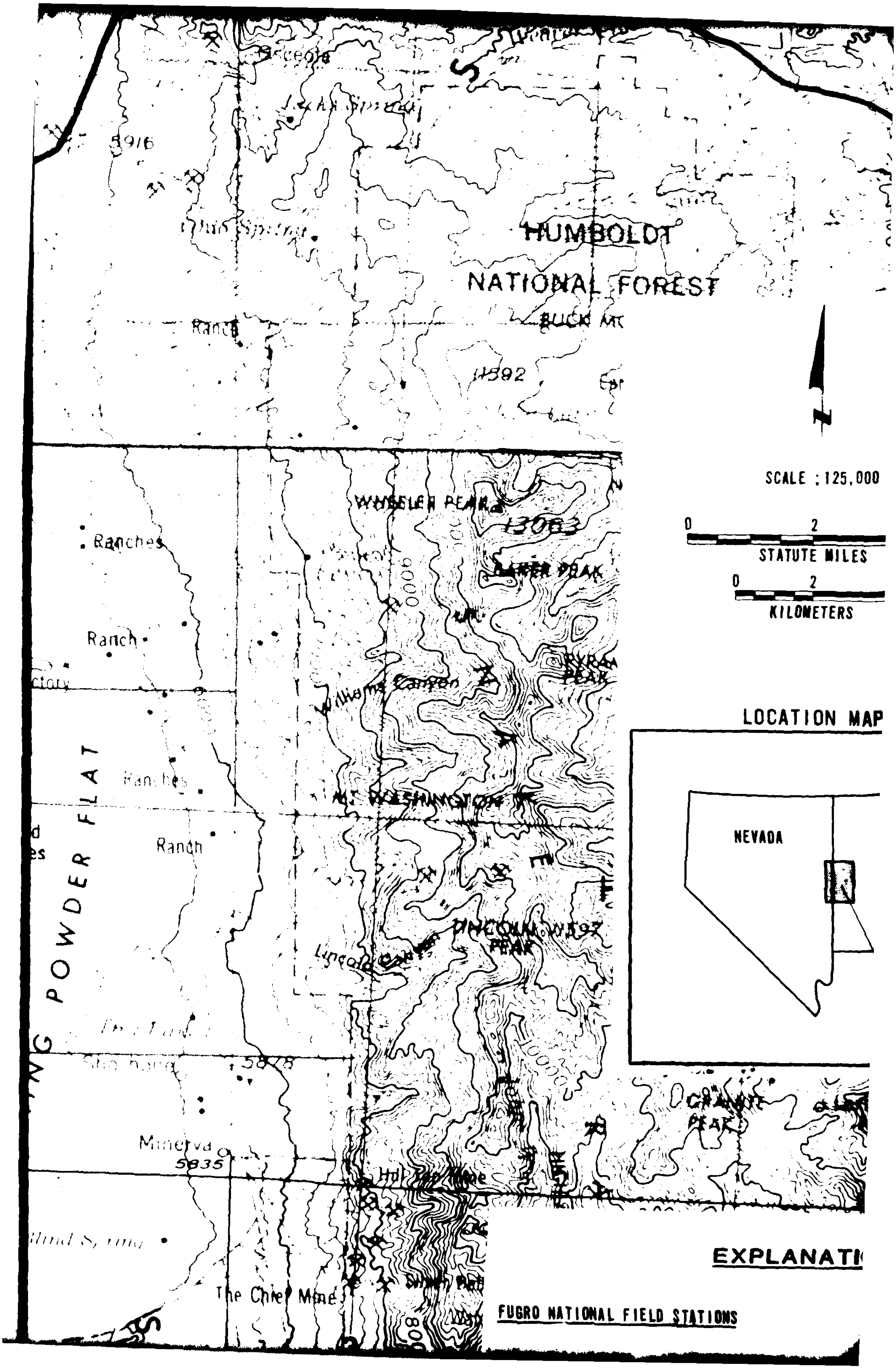


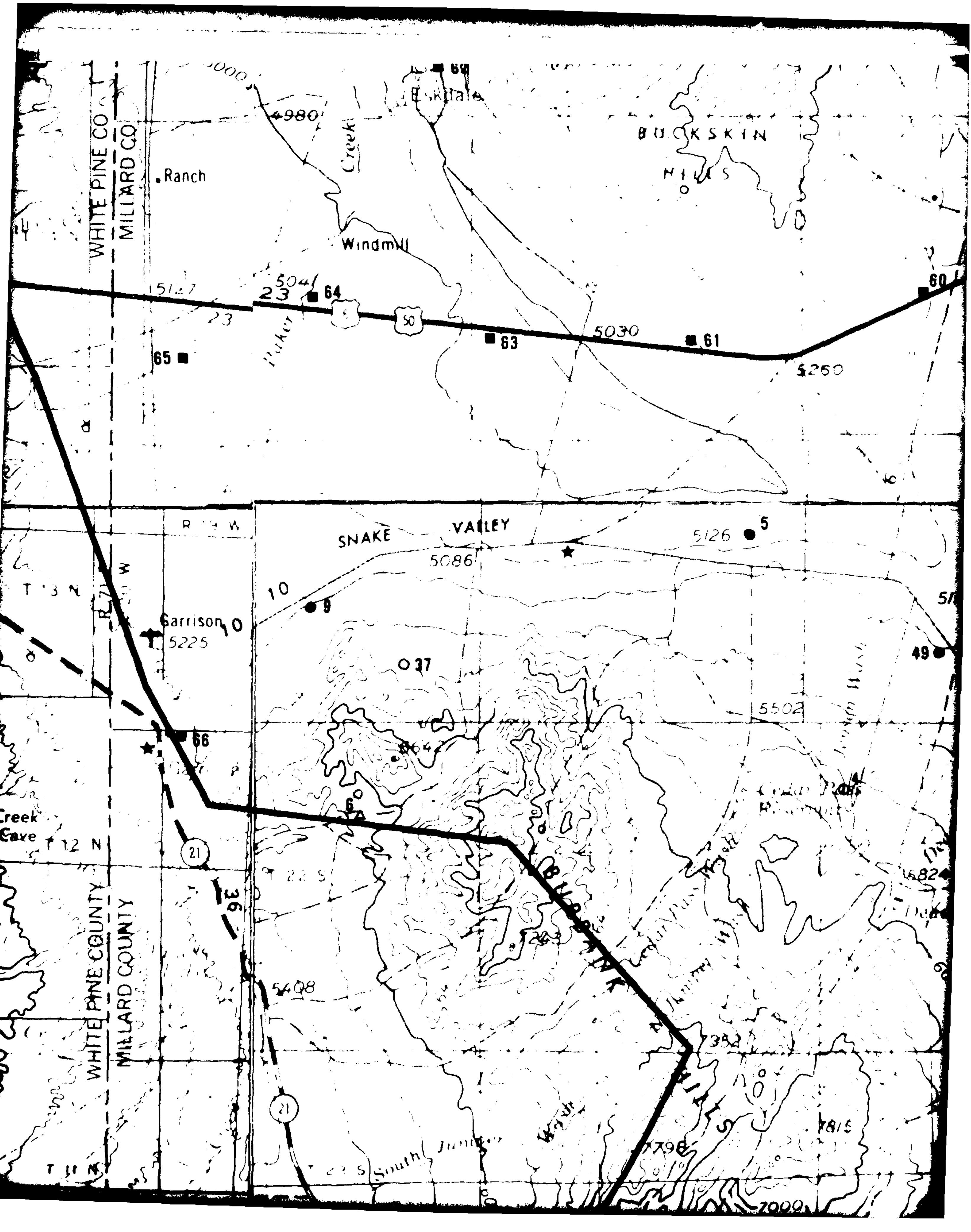
ONAL FOREST
9000
8000
10000
Ranch
17
Ruins
4963
5
58
18
16
20
5033
Rock Canyon
15
NEVADA
UTAH
WHITE PINE CO
MILLARD CO
S N A K E
Ranch
Ranch
Ranch
4980
Creek
62
Windmill
64
5127
23
23
50
63
5456
65
Ranch
Baker
R 19 W
SNAKE VALLEY
5086
Baker
5364
T 13 N
10
9
Garrison
5225
37



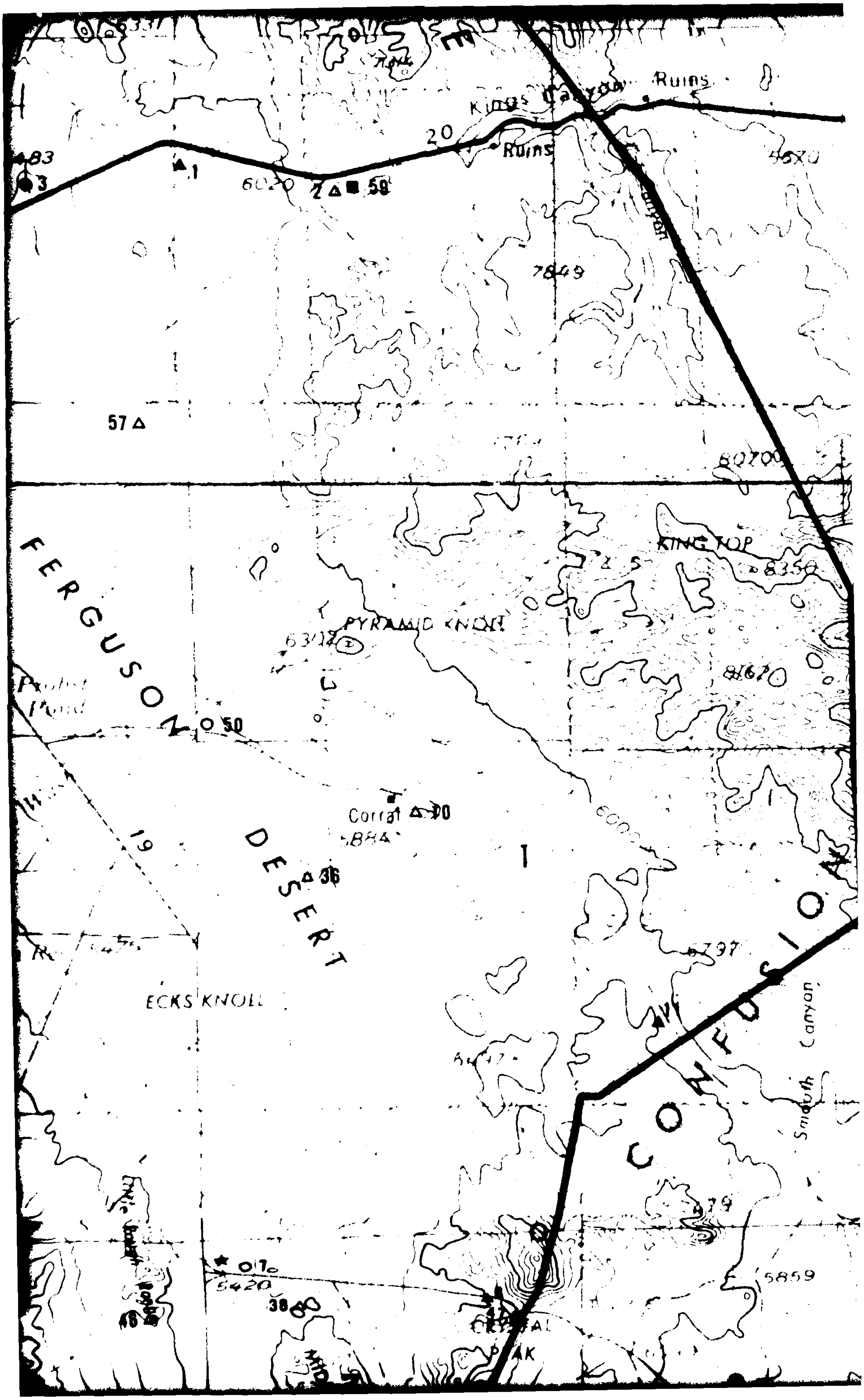
Rattlesnake
5510
Corral
CONGER MOUNTAIN
7430
6
7
8
4815
6484
6930
RANGE
5190
6540
Little Valley
6864
7505
4740
19
Kings Canyon Ruins
20
Ruins
5483
3
1
6020
2
58
60
7849
5260
57
8070
5
FERO
5114
KING TOP


MOUNTAIN
7
8
V
A
L
L
E
Y
4
3
2
R
A
N
G
E
5190
6540
6864
7506
7849
6020
Valley
Kings Canyon Ruins
Ruins
20
1
2
58
KING TOP
8350
PYRAMID KNOB
6302
NGE

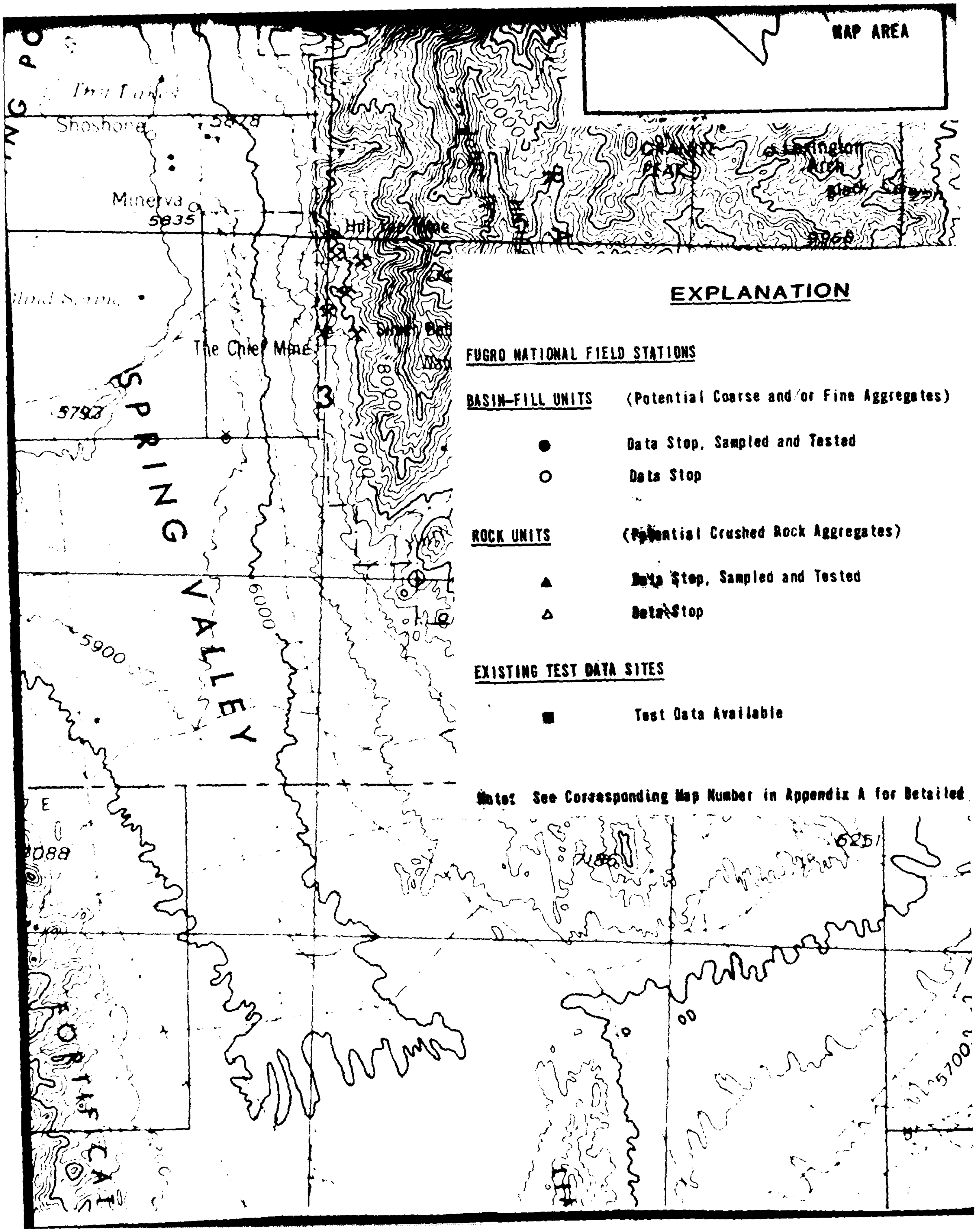

Osceola
HUMBOLDT
NATIONAL FOREST
5916
11592
Ranch
WHEELER PEAK
13063
BAKER PEAK
Ranches
Ranch
Williams Canyon
PYRAMID PEAK
Ranches
MT. WASHINGTON
Ranch
POWDER FLAT
LINCOLN PEAK
Lincoln Canyon
5878
Minerva
5835
GRANITE PEAK
The Chief Mine
SCALE 1:125,000
0
2
STATUTE MILES
0
2
KILOMETERS
LOCATION MAP
NEVADA
EXPLANATI
FUGRO NATIONAL FIELD STATIONS



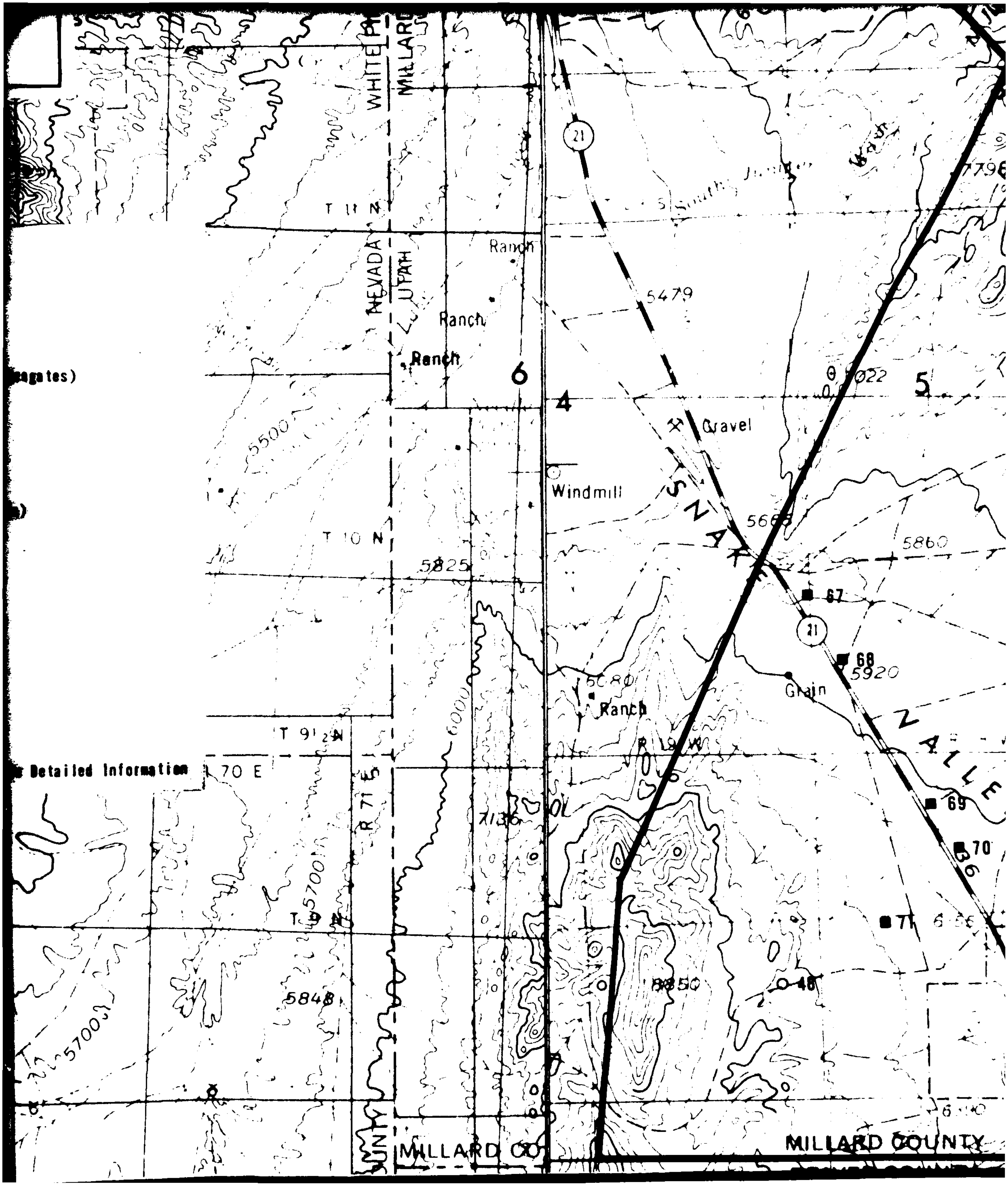
WHITE PINE CO
MILLARD CO
Ranch
4980
Creek
BUCKSKIN
HILLS
Windmill
5127
5041
23
64
50
5030
63
61
60
5250
65
SNAKE
VALLEY
5086
5126
5
10
9
Garrison
5225
37
49
5502
66
Creek
Cave
T 12 N
21
WHITE PINE COUNTY
MILLARD COUNTY
5408
7798
2000

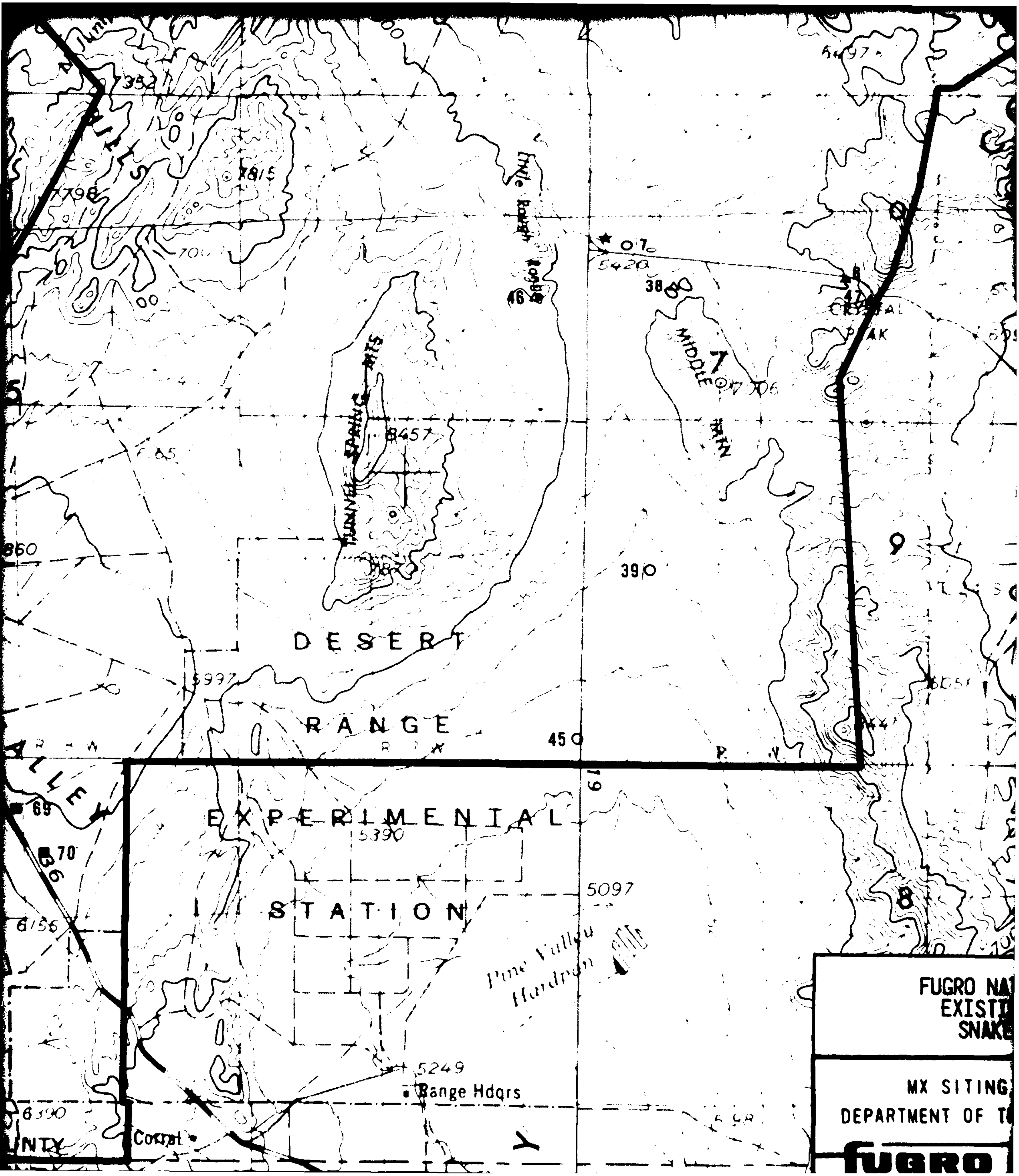


Kings Canyon
Ruins
20
Ruins
6020
7849
57
8070
KING TOP
8350
PYRAMID KNOLL
8162
FERGUSON
Corral
DESERT
19
6000
36
ECKS KNOLL
CONFUSION
Canyon
5859
6420
CRYSTAL PEAK

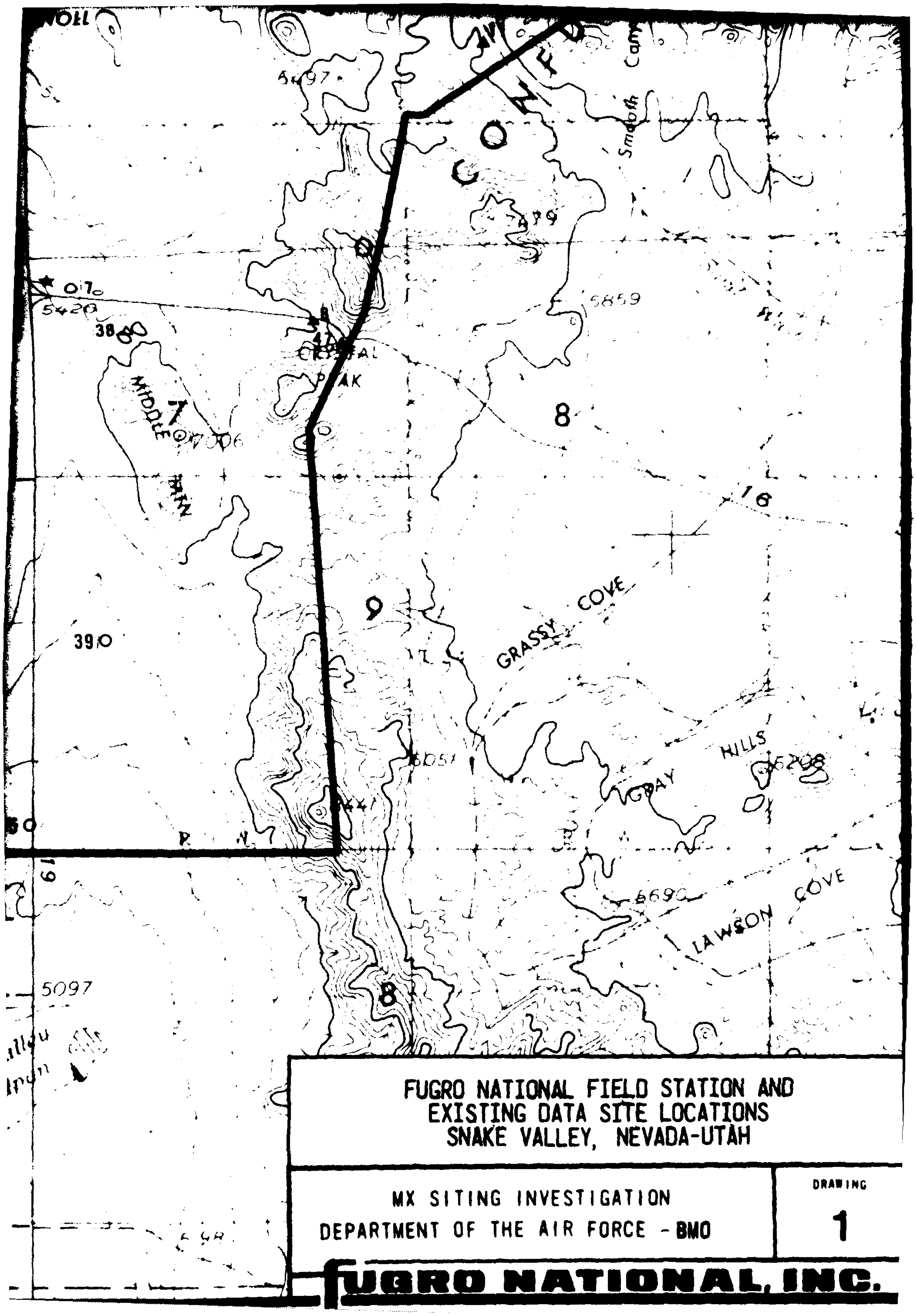


MAP AREA
EXPLANATION
FUGRO NATIONAL FIELD STATIONS
BASIN-FILL UNITS (Potential Coarse and/or Fine Aggregates)
Data Stop, Sampled and Tested
Data Stop
ROCK UNITS (Potential Crushed Rock Aggregates)
Data Stop, Sampled and Tested
Data Stop
EXISTING TEST DATA SITES
Test Data Available
Note: See Corresponding Map Number in Appendix A for Detailed
Shoshone
Minerva
5835
The Chief Mine
5793
SPRING VALLEY
5900
6000
7000
8000
3
5700


WHITE PINE
MILLARD
NEVADA
UTAH
T 11 N
T 10 N
T 9½ N
T 9 N
R 71 E
R 70 E
R 19 W
21
Ranch
Ranch
Ranch
Ranch
5479
7022
6
4
5
Gravel
Windmill
SNAKE
VALLEY
5668
5860
5825
5500
6000
5700
5700
5848
7136
5080
5920
67
68
69
70
71
48
Grain
8850
MILLARD CO
MILLARD COUNTY
Detailed Information



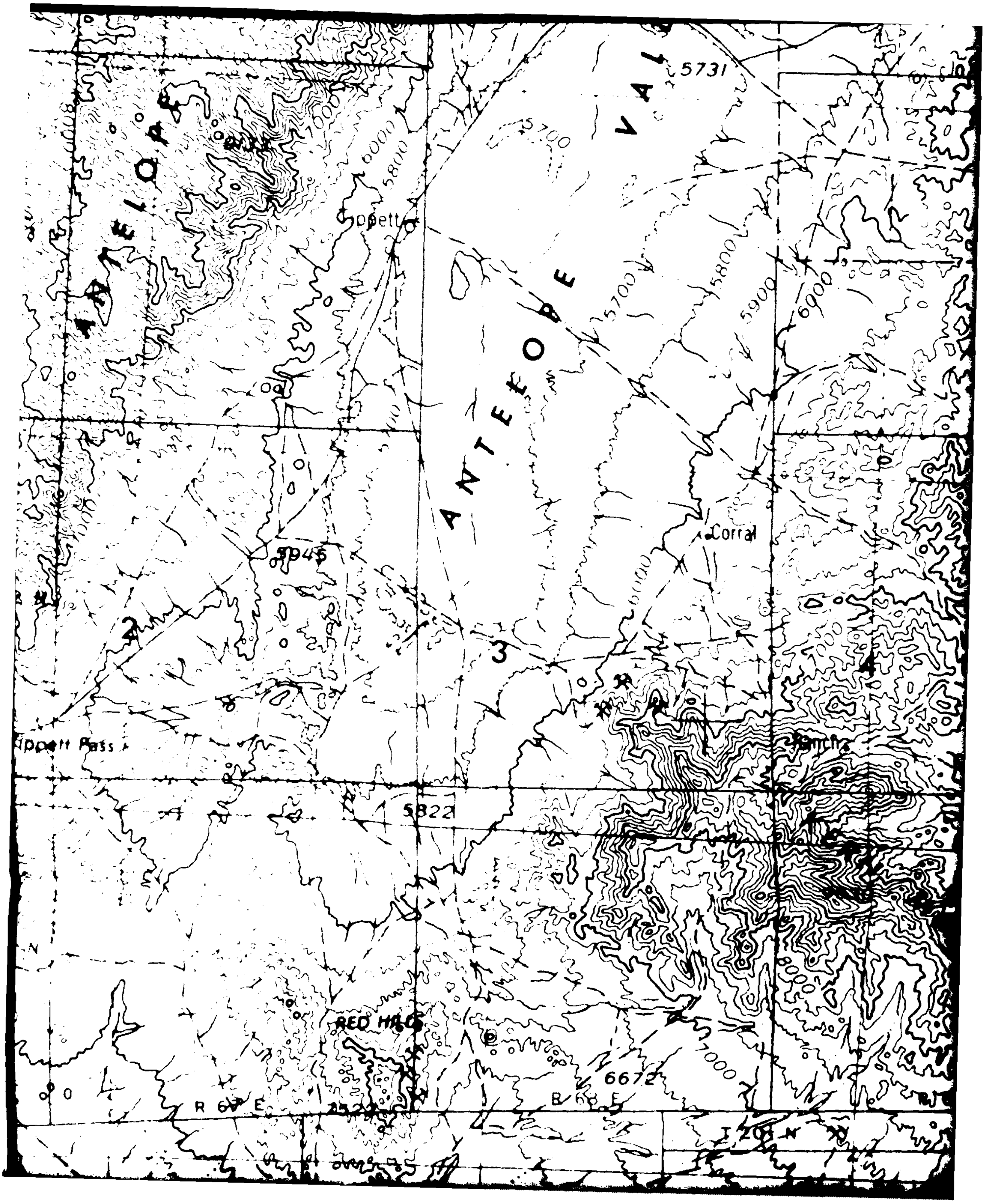
DESERT
RANGE
EXPERIMENTAL
STATION
TUNNEL SPRING MTS
MIDDLE MTN
CRYSTAL PEAK
Pine Valley Hardpan
Range Hdqrs
Corral
5249
5097
5390
5997
5420
FUGRO NA
EXISTI
SNAKE
MX SITING
DEPARTMENT OF T
fugro



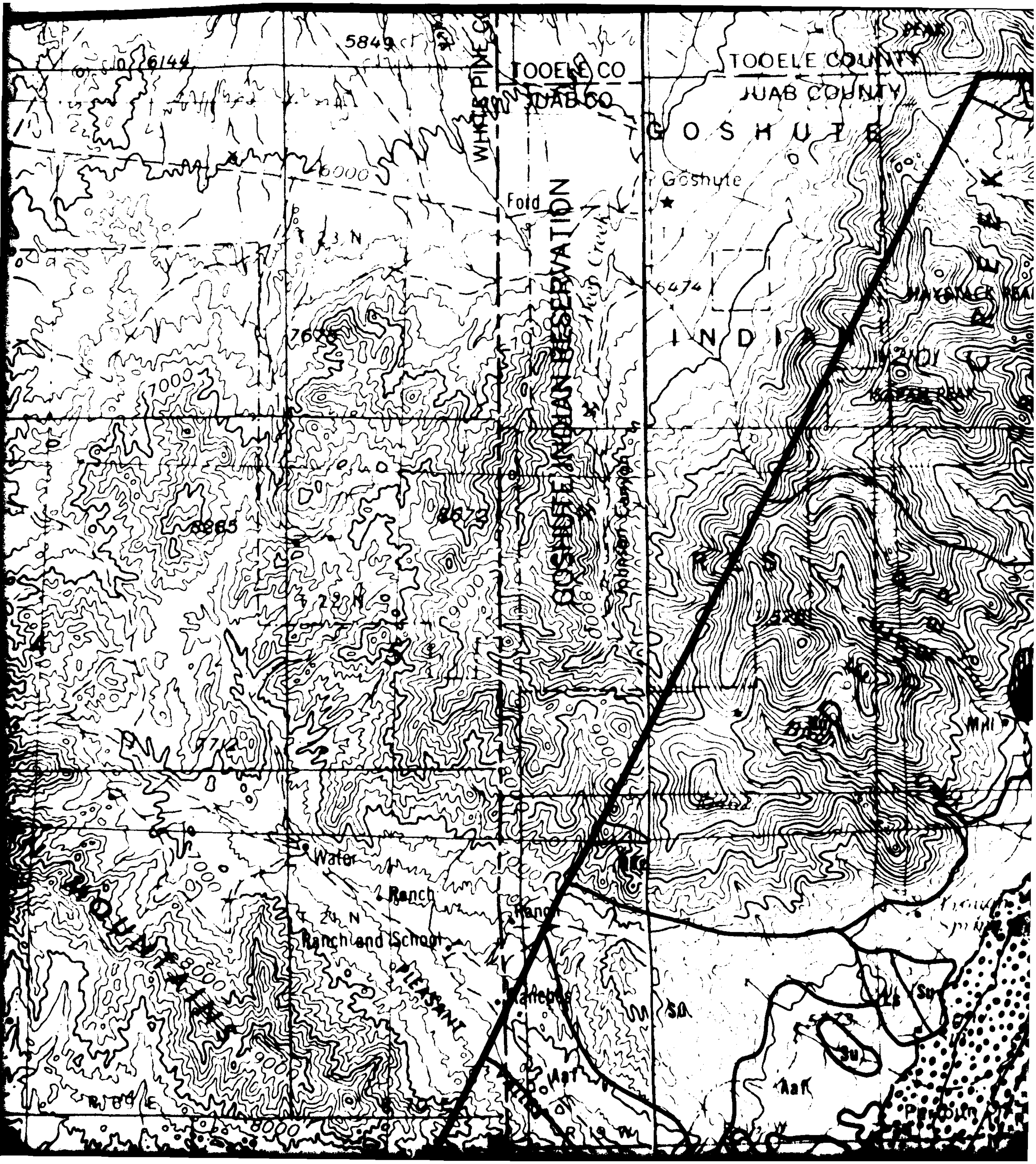
FUGRO NATIONAL FIELD STATION AND
EXISTING DATA SITE LOCATIONS
SNAKE VALLEY, NEVADA-UTAH

MX SITING INVESTIGATION DEPARTMENT OF THE AIR FORCE - BMO	DRAWING 1

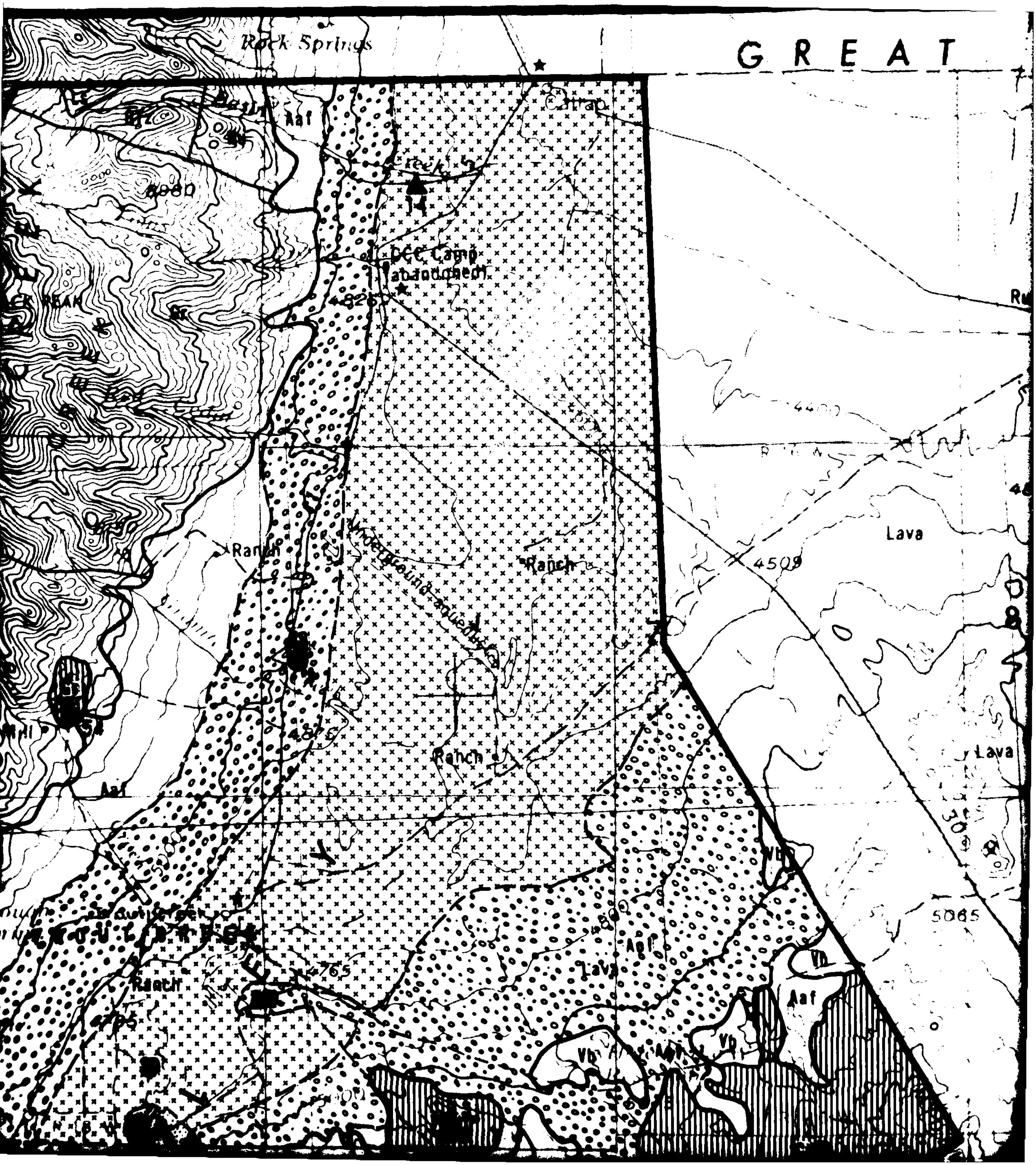
FUGRO NATIONAL, INC.



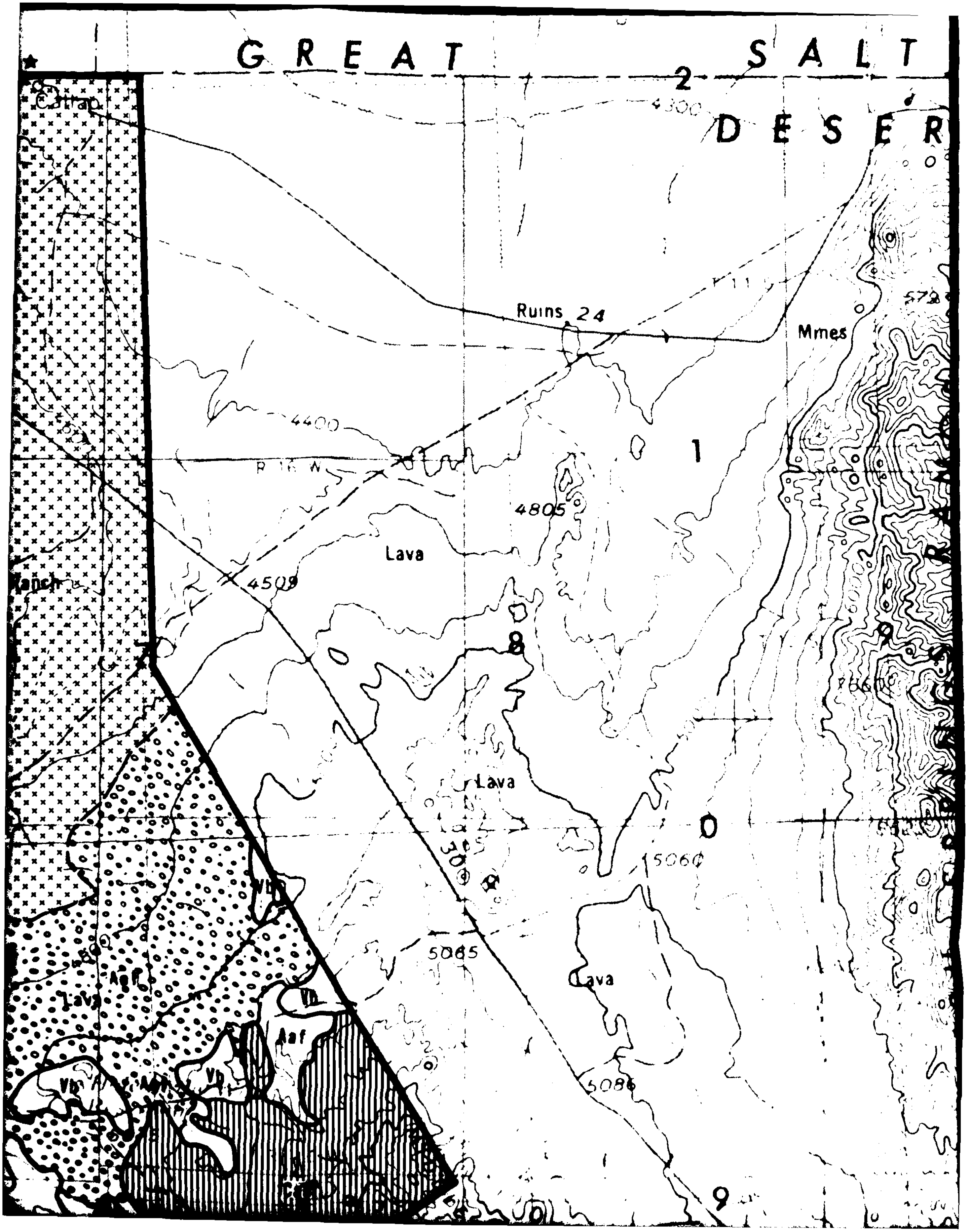
ANTELOPE
ANTELOPE VAL
5731
5700
7000
6000
5800
Spplett
5700
5800
5900
6000
Corral
5945
2
3
4
Spplett Pass
5822
RED HILL
6672
7000
R 67 E
R 68 E
T 20 N

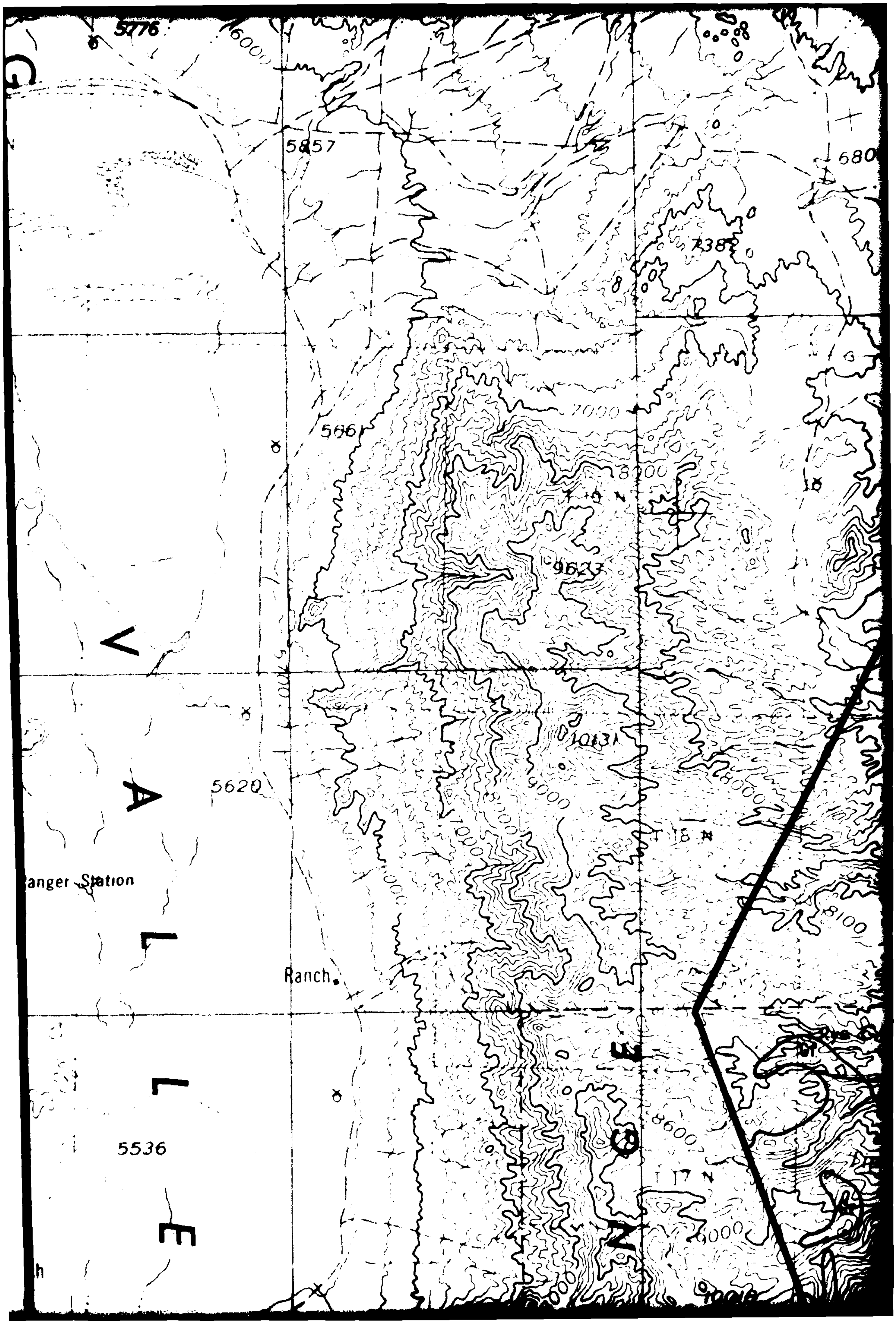


TOOELE CO
JUAB CO
TOOELE COUNTY
JUAB COUNTY
GOSHUTE
Goshute
WHITE PINE CO
Fold
GOSHUTE INDIAN RESERVATION
INDIAN
5849
6144
6000
6474
7000
7676
8865
8673
T 23 N
T 22 N
T 21 N
Water
Ranch
Ranchland School
PLEASANT
MOUNTAINS
R 69 E
R 19 W
8000
9000

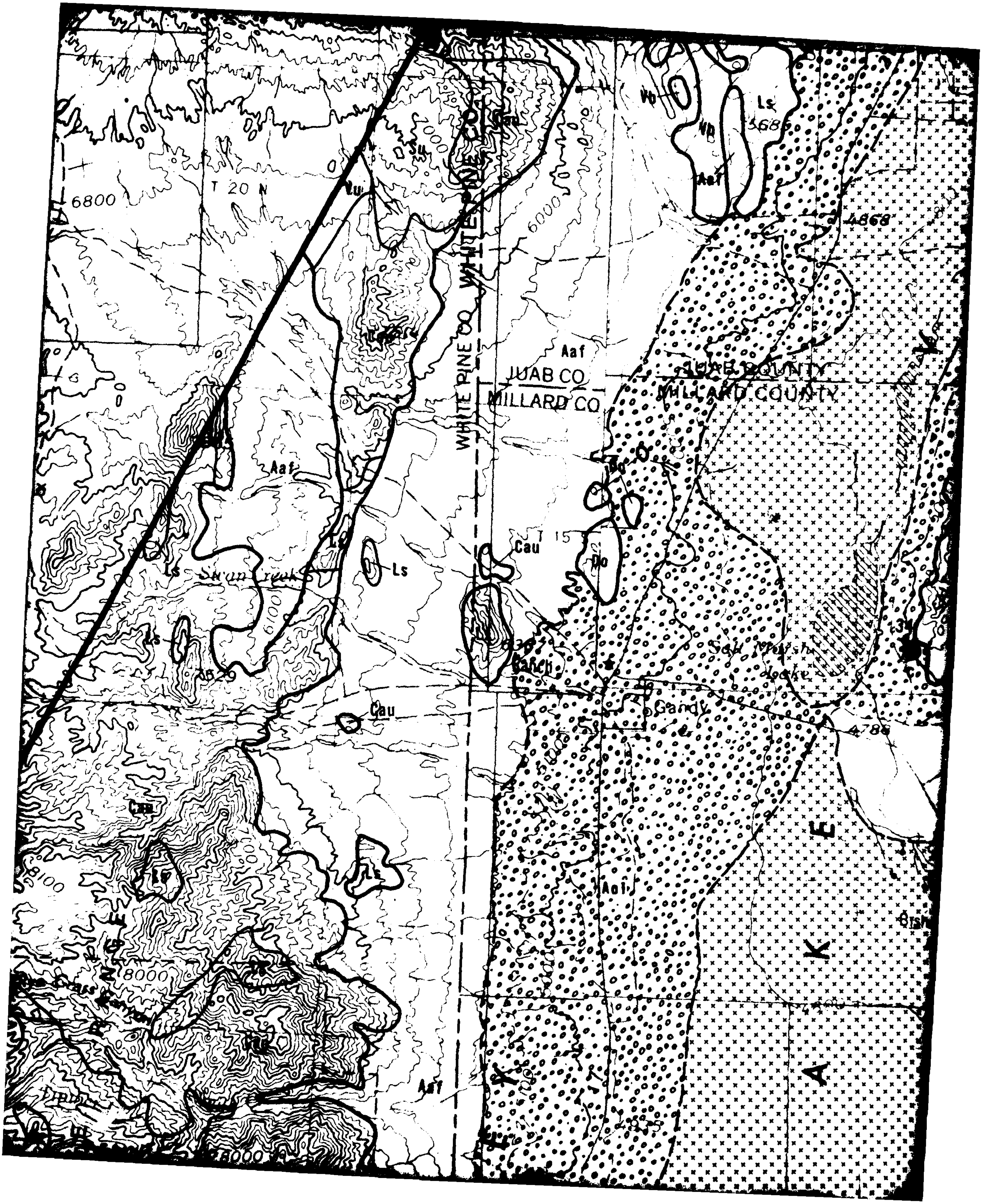


Rock Springs
GREAT
CCC Camp
(abandoned)
4826
Ranch
Ranch
Underground aqueduct
Ranch
Lava
Lava
4509
5065
Aaf
Vb

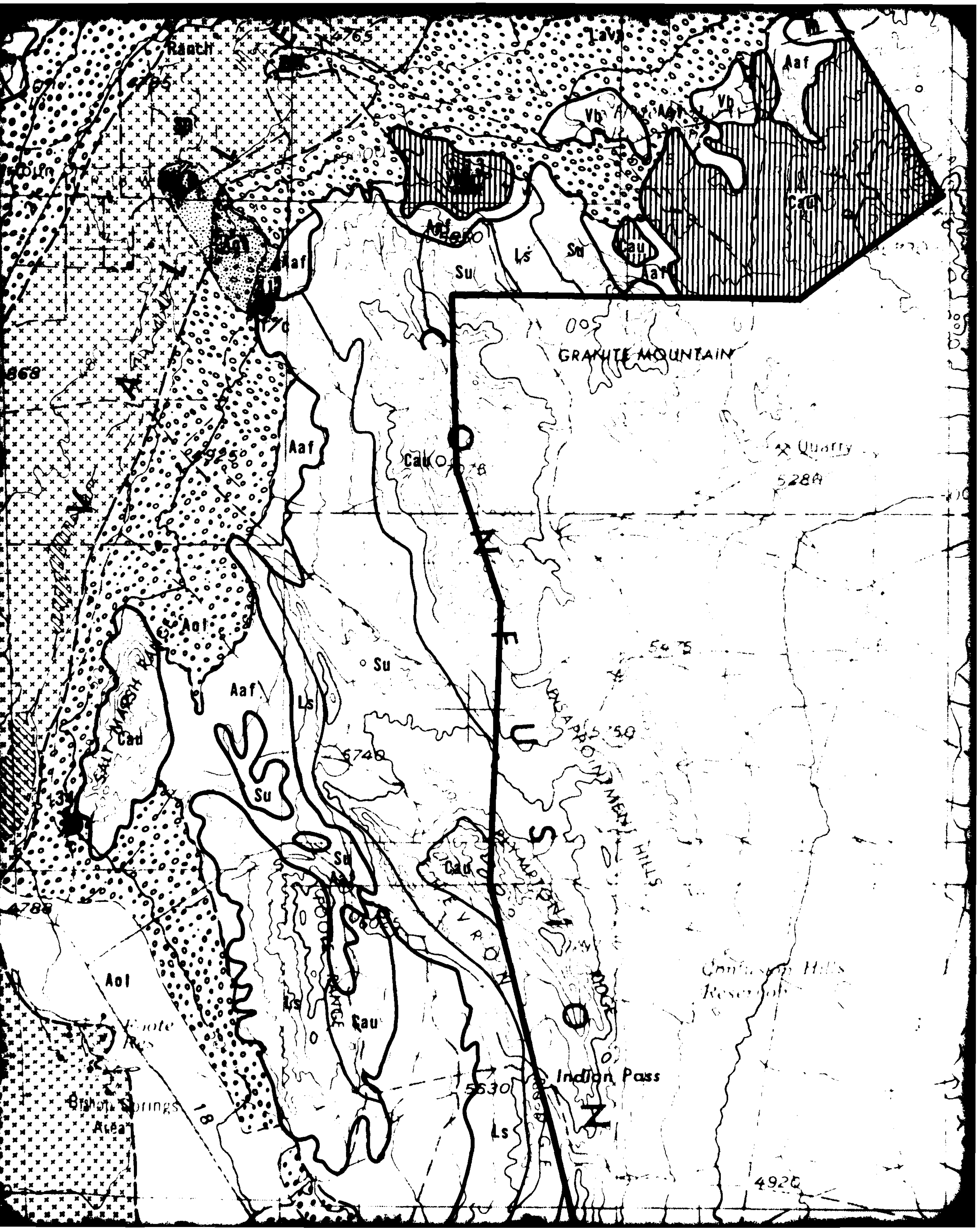

GREAT SALT
DESER
2
4300
Ruins 24
Mmes
4400
R 16 W
1
4805
Lava
4509
Ranch
8
Lava
0
5060
5065
Lava
Vb
Aaf
5086
9



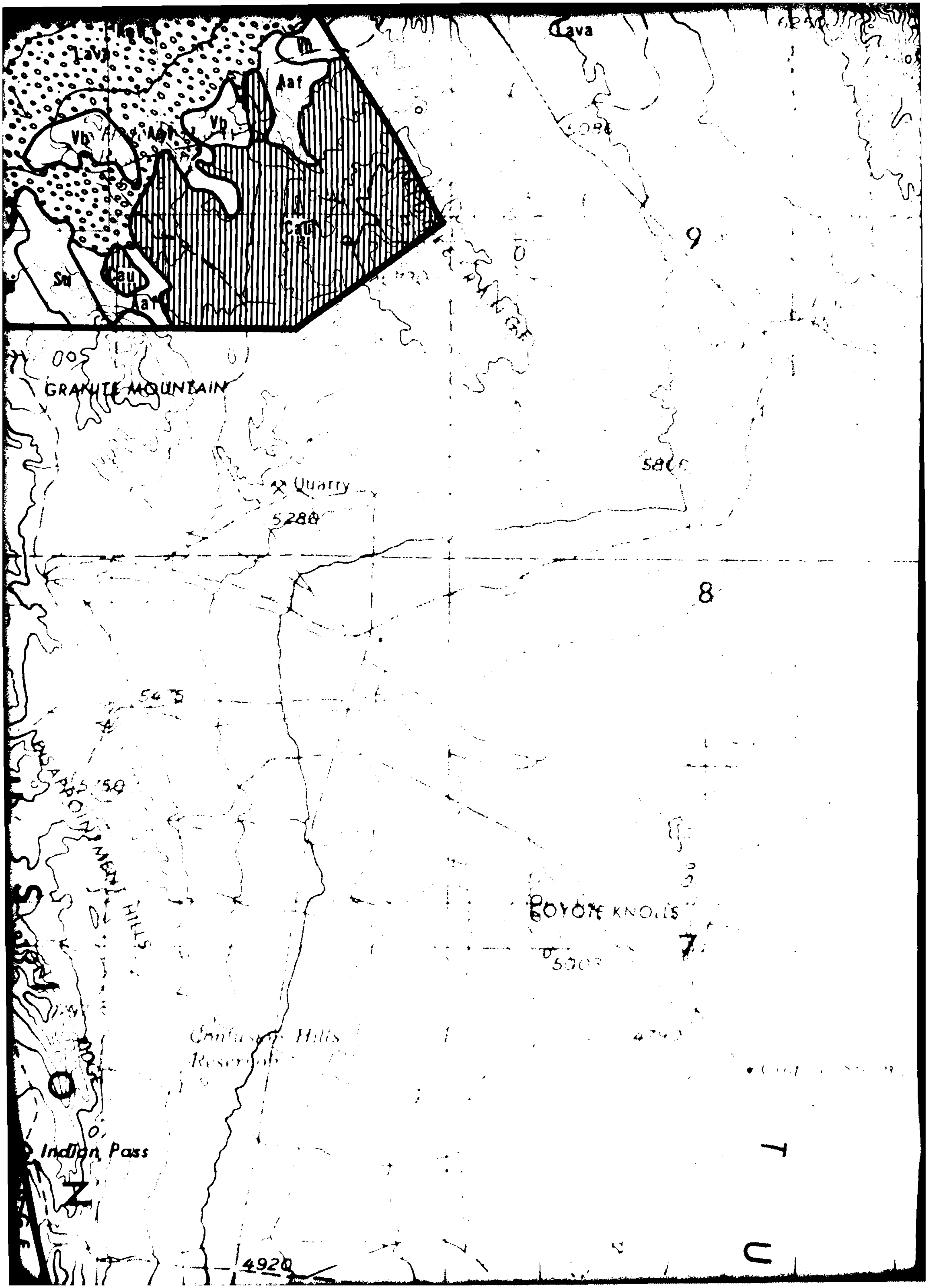
5776
6000
5857
680
738
7000
5661
8000
T 19 N
9623
10131
9000
5620
8000
T 18 N
7000
anger Station
8100
Ranch
5536
8600
T 17 N
9000
V A L L E



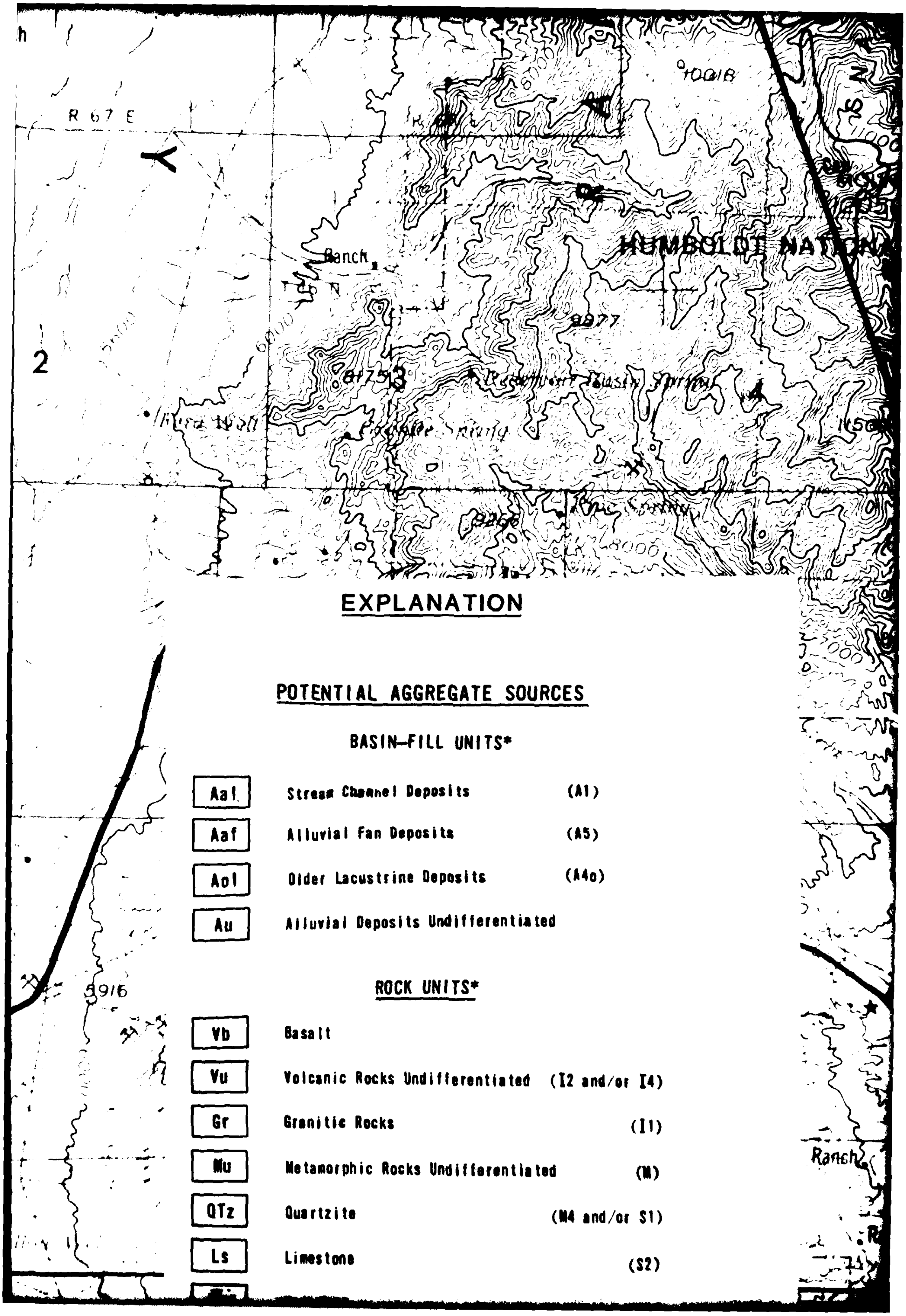
T 20 N
6800
WHITE PINE CO.
JUAB CO
MILLARD CO
JUAB COUNTY
MILLARD COUNTY
Aaf
Cau
Ls
Swan Creek
6100
6000
7000
8000
8100
Do
T 15
Gandy
4868
4786
K
E
A



Ranch
Lava
GRANITE MOUNTAIN
Quarry
SALT MARSH RANGE
DELAMAR
Indian Pass
Bishop Springs Area
Aaf
Aol
Cad
Cau
Su
Ls
Vb
5630
5740
4920
4788



Lava
Vb
Aaf
Cau
Su
GRANITE MOUNTAIN
Quarry
5280
5800
9
8
7
COYOTE KNOLLS
Indian Pass
4920



EXPLANATION

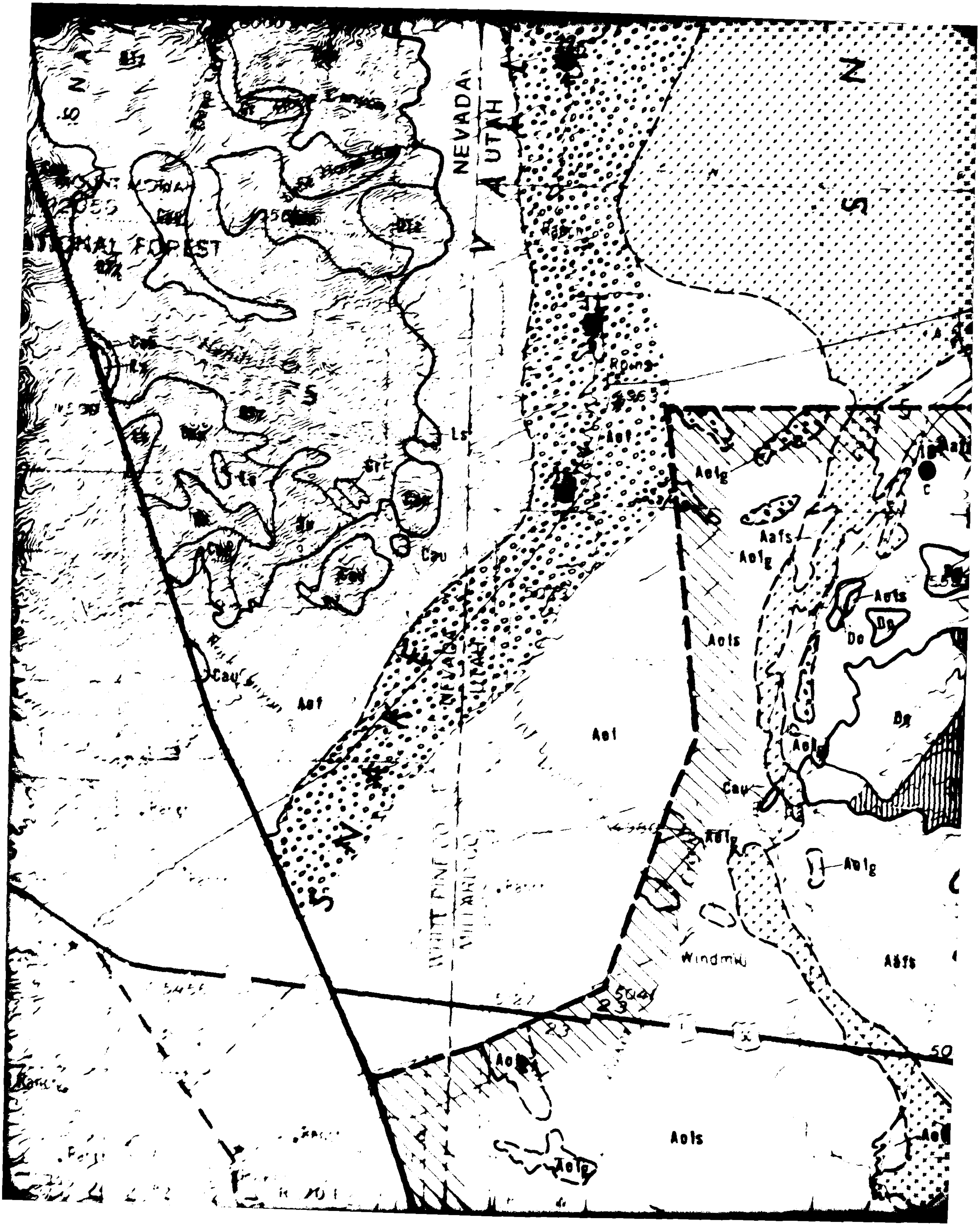
POTENTIAL AGGREGATE SOURCES

BASIN–FILL UNITS*

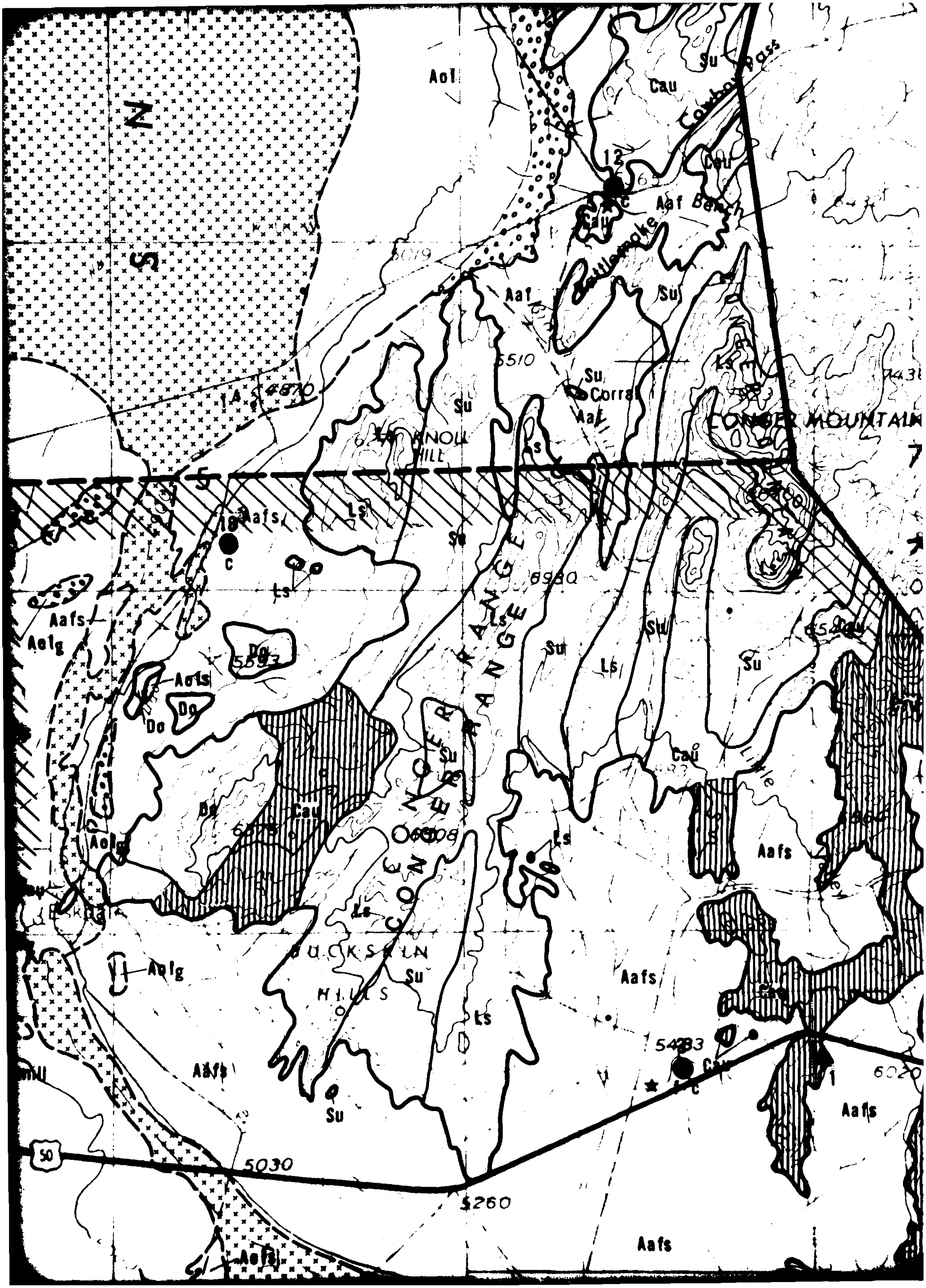
Aal	Stream Channel Deposits	(A1)
Aaf	Alluvial Fan Deposits	(A5)
Aol	Older Lacustrine Deposits	(A4o)
Au	Alluvial Deposits Undifferentiated	

ROCK UNITS*

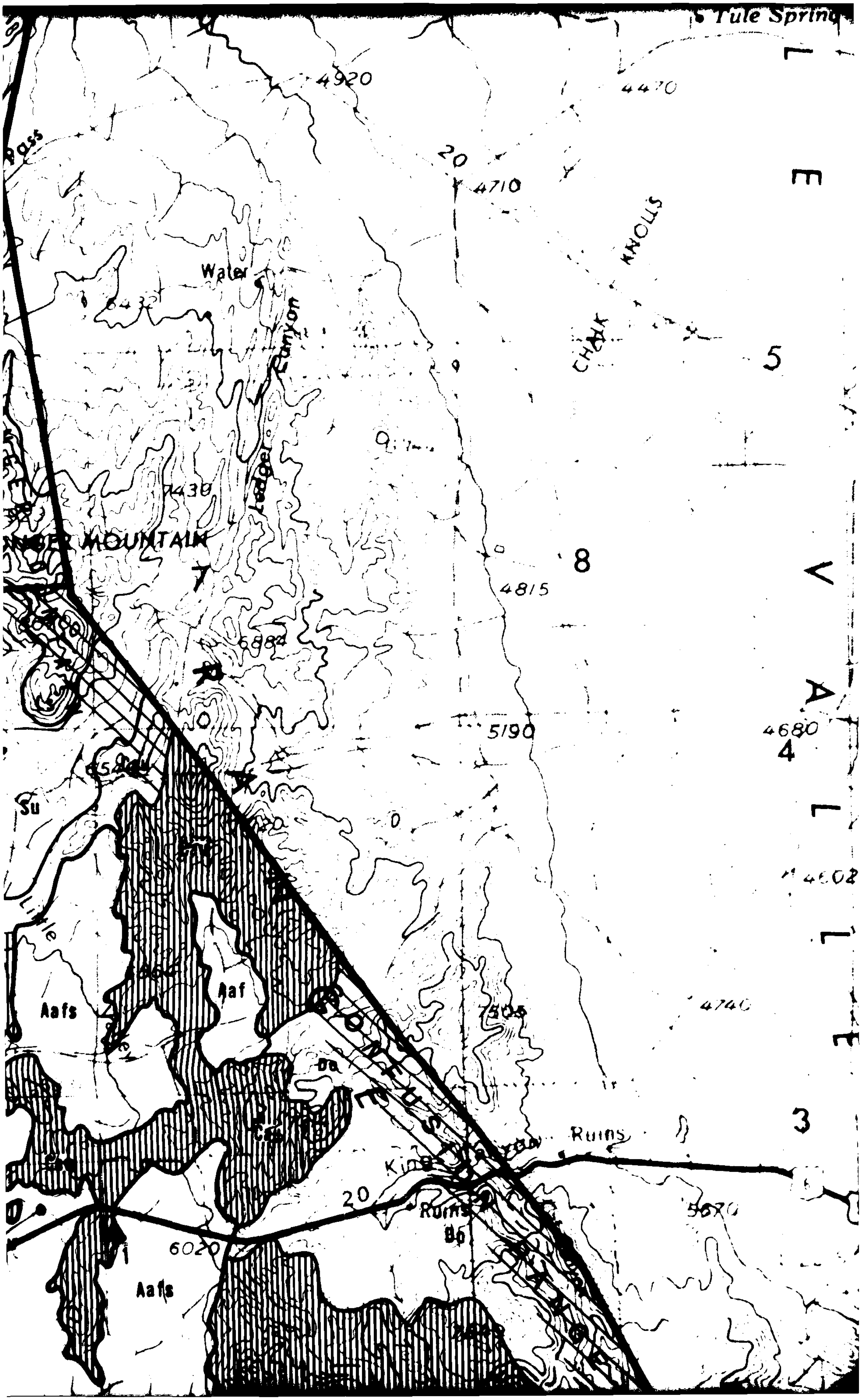
Vb	Basalt	
Vu	Volcanic Rocks Undifferentiated	(I2 and/or I4)
Gr	Granitic Rocks	(I1)
Mu	Metamorphic Rocks Undifferentiated	(M)
QTz	Quartzite	(M4 and/or S1)
Ls	Limestone	(S2)



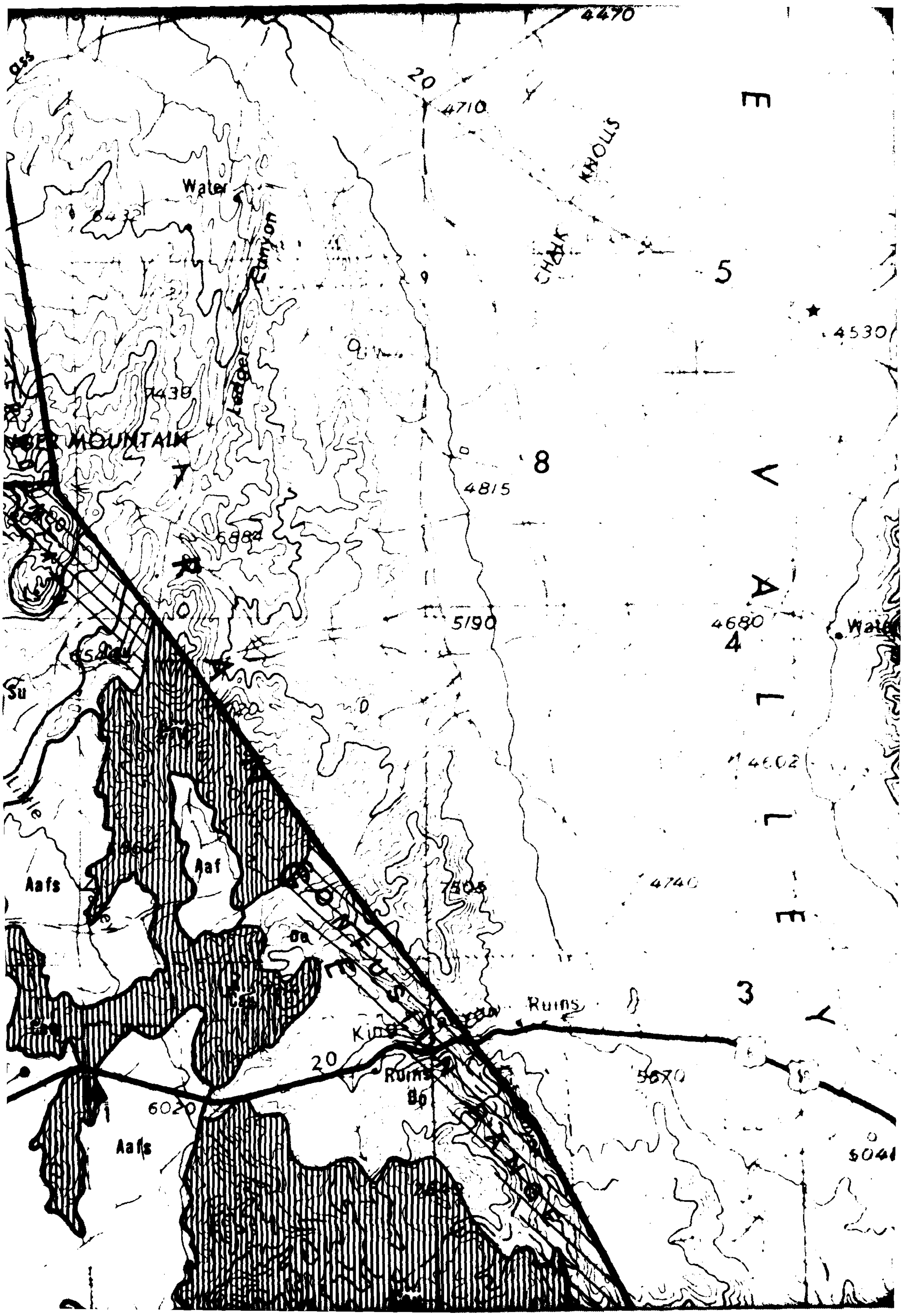
NEVADA
UTAH
NEVADA
UTAH
WHITE PINE CO
MILLARD CO
5963
Ls
Cau
Aof
Aolg
Aafs
Aols
Do
Windmill

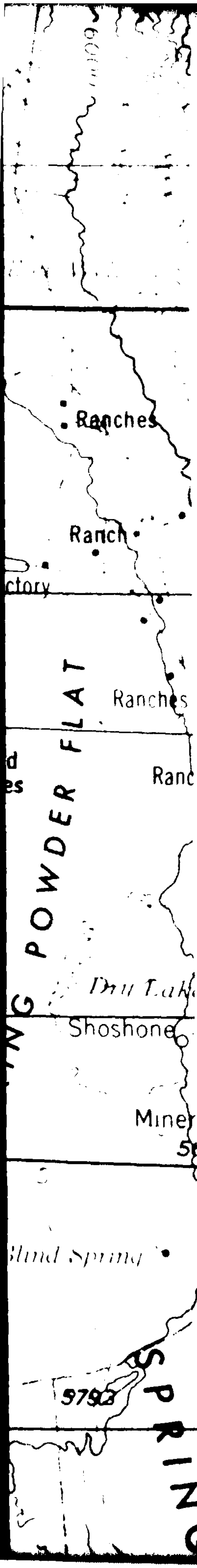


Aol
Cau
Su
Cowboy Pass
12
Aaf Basin
Rattlesnake
Aaf
Su
5510
Corral
KNOLL HILL
LA
4870
CONGER MOUNTAIN
Aafs
Ls
10
Aafs
Aolg
Aols
Do
5593
6930
CONGER RANGE
Su
Ls
Cau
Aafs
Aolg
BUCKSKIN HILLS
5483
Aafs
50
5030
5260
6020



Tule Spring
4920
4470
Pass
20
4710
CHALK KNOLLS
Water
Canyon
Ledge
7430
MOUNTAIN
5
8
4815
6884
5190
4680
4
Su
4602
Aafs
Aaf
4740
3
Ruins
King
20
Ruins
6020
5670
Aafs


4470
20
4710
CHALK KNOLLS
Water
Canyon
5
4530
MOUNTAIN
8
4815
V A L L E Y
5190
4680
4
Water
4602
4740
Aafs
Aaf
3
Ruins
20
Ruins
5670
6020
Aafs



Vu	Volcanic Rocks Undifferentiated (I2 and/or I4)
Gr	Granitic Rocks (I1)
Mu	Metamorphic Rocks Undifferentiated (M)
QTz	Quartzite (M4 and/or S1)
Ls	Limestone (S2)
Do	Dolomite (S2)
Cau	Carbonate Rocks Undifferentiated (S2)
Su	Sedimentary Rocks Undifferentiated (S)

*Reference Appendix E for Symbol Explanation and Comparison

SYMBOLS

Aafg — Material type (Aaf) and Grain Size Designation (g)
Grain size designations are gravel (g) and sand (s)
and are assigned only in Verification Study Areas

Geologic Contact Dashed Where Approximate

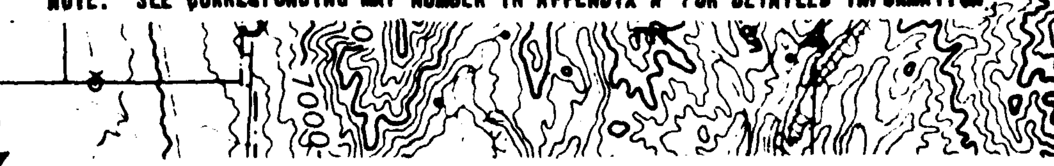
Approximate Concrete Aggregate and/or
Road-Base Materials Source Boundary

Verification Study Area

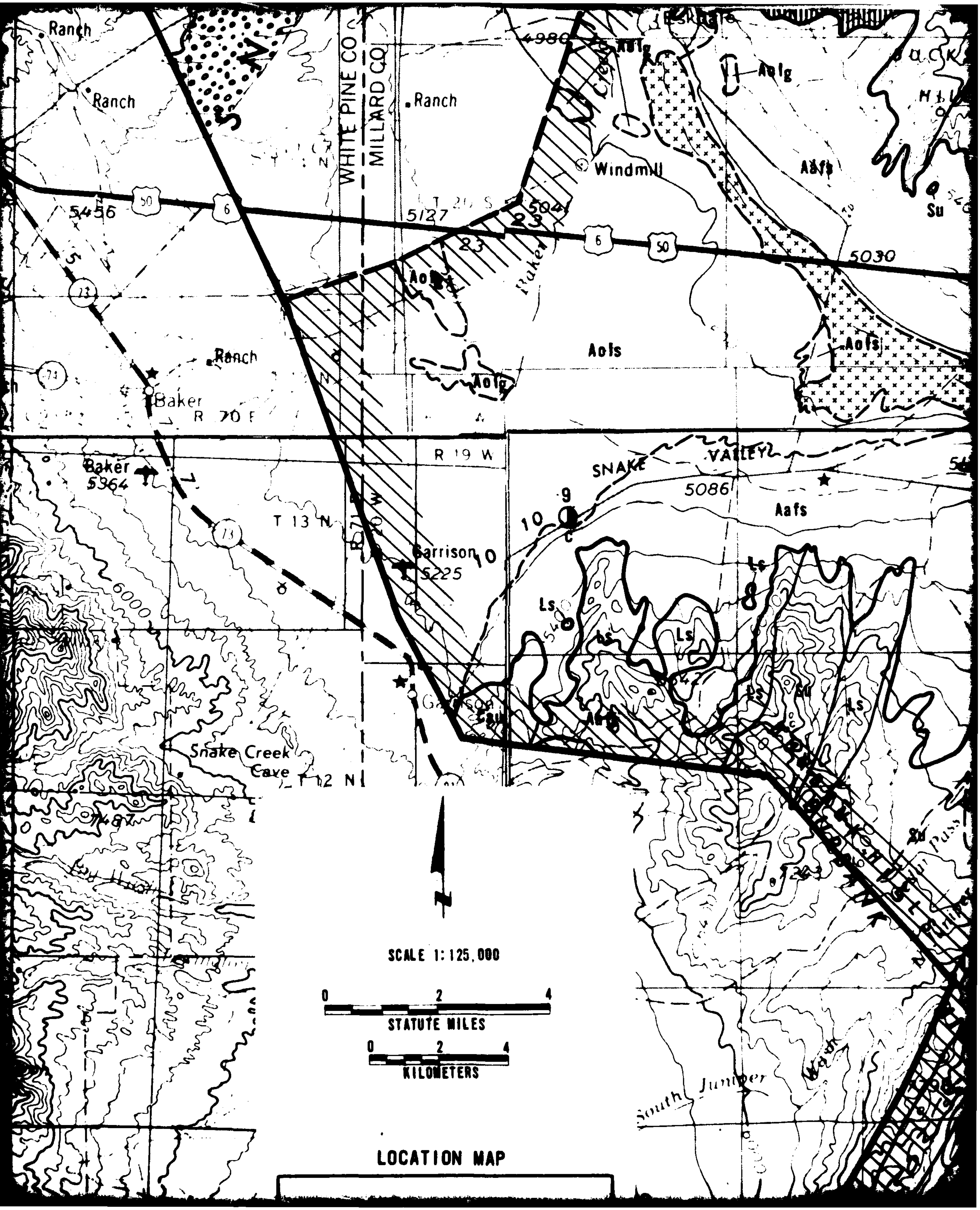
FUGRO NATIONAL AGGREGATE RESOURCES
SAMPLED AND TESTED FIELD STATIONS

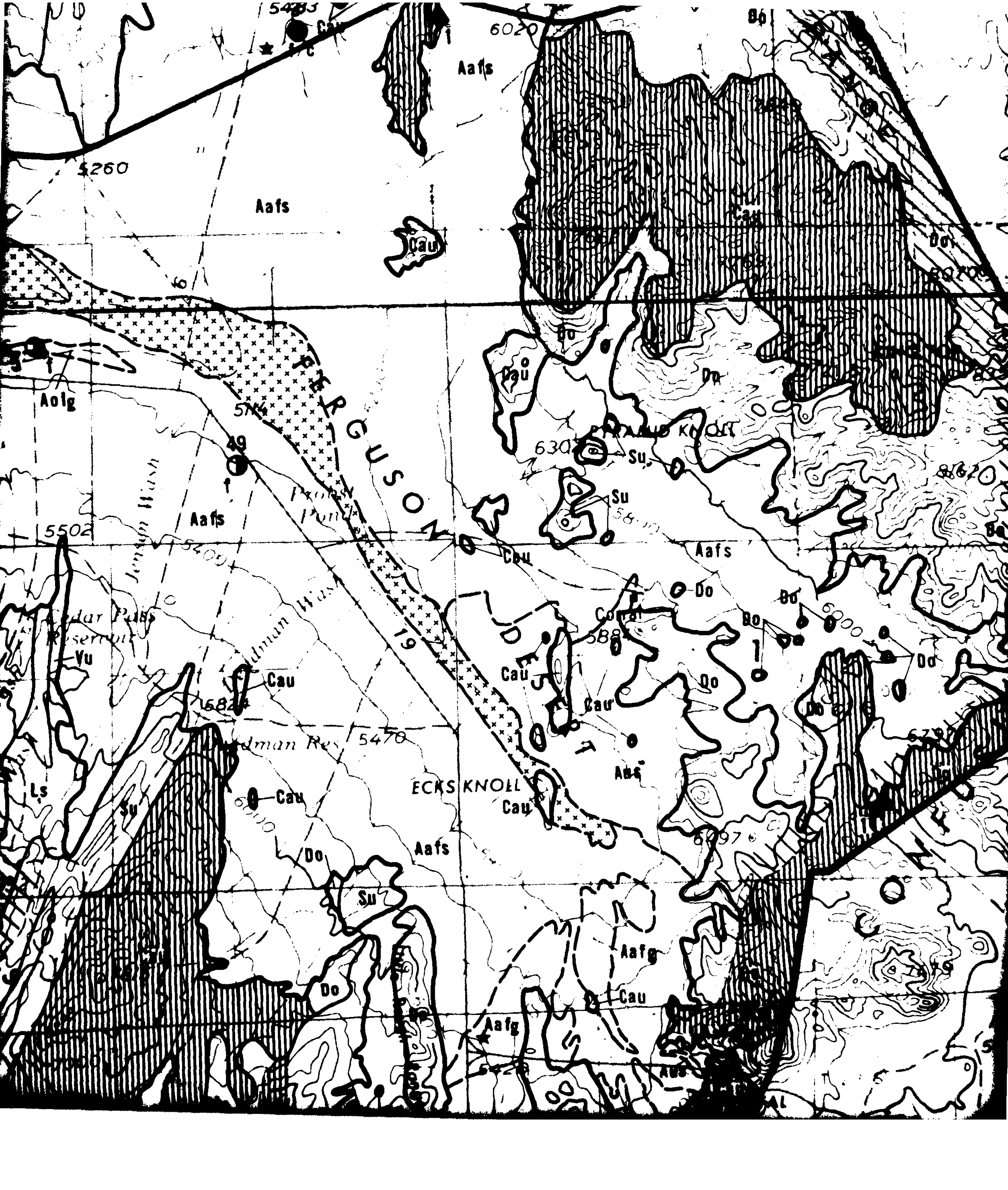
BASIN-FILL AGGREGATE SAMPLE COARSE (c) AND FINE (f)	CRUSHED ROCK SAMPLE	CLASSIFICATION
●	▲	CLASS I
◐	◭	CLASS II
○	△	CLASS III

NOTE: SEE CORRESPONDING MAP NUMBER IN APPENDIX A FOR DETAILED INFORMATION.

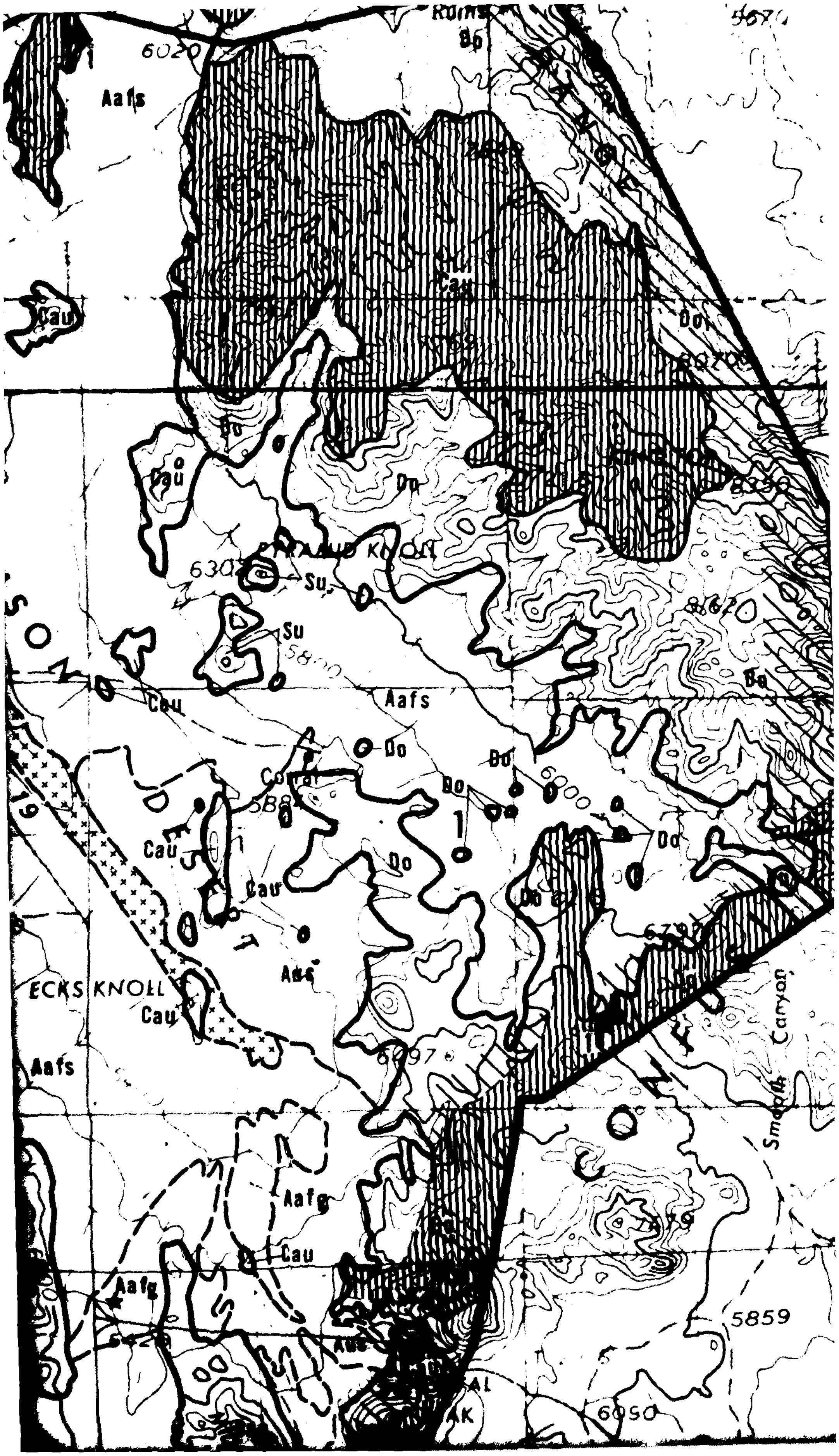


CLASSIFICATION SYSTEM

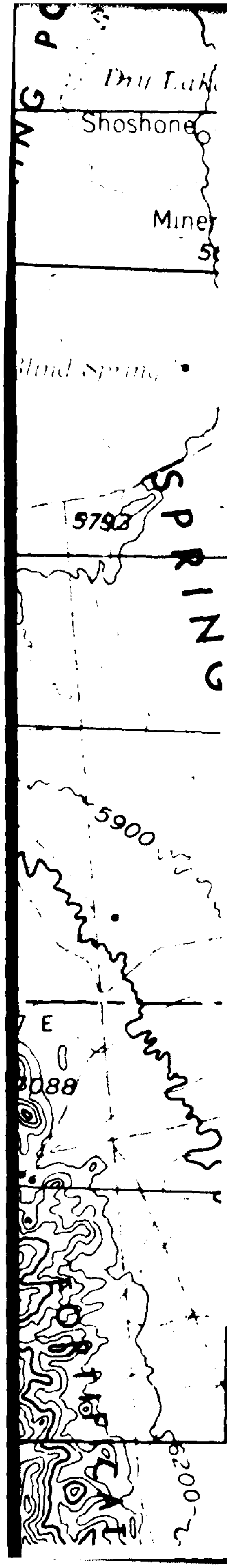

Ranch
Ranch
Ranch
Ranch
WHITE PINE CO
MILLARD CO
Windmill
Aolg
Aafs
Aols
Su
5456
5127
5041
5030
4980
23
Baker
Ls
Lc
Baker
5364
R 70 E
R 19 W
SNAKE VALLEY
5086
T 13 N
Garrison
5225
6000
Snake Creek
Cave
T 12 N
7487
SCALE 1:125,000
0 2 4
STATUTE MILES
0 2 4
KILOMETERS
South Juniper Wash
LOCATION MAP



Aafs
Cau
5260
6020
Do
Aolg
FERGUSON
DESERT
5114
49
Jensen Wash
5502
Vu
Su
Ls
6824
5470
ECKS KNOLL
Aafg
Aus
6302
6997



Ruins
6020
Aafs
Cau
Do
PYRAMID KNOLL
6302
Su
Aafs
Cau
19
ECKS KNOLL
Cau
Aafs
Aafg
Cau
Aafg
5859
6050
Smoot Canyon



Verification Study Area

FUGRO NATIONAL AGGREGATE RESOURCES
SAMPLED AND TESTED FIELD STATIONS

BASIN-FILL AGGREGATE SAMPLE COARSE (c) AND FINE (f)	CRUSHED ROCK SAMPLE	CLASSIFICATION
●	▲	CLASS I
◐	▲	CLASS II
○	△	CLASS III

NOTE: SEE CORRESPONDING MAP NUMBER IN APPENDIX A FOR DETAILED INFORMATION.

CLASSIFICATION SYSTEM

BASIN-FILL SOURCES

Class I - Potentially Suitable Coarse, Concrete Aggregate and Road-Base Material Source

Class I - Potentially Suitable Coarse and Fine (Multiple Sou... Concrete Aggregate and Road-Base Material Source

Class I - Potentially Suitable Fine Concrete Aggregate and Road-Base Material Source

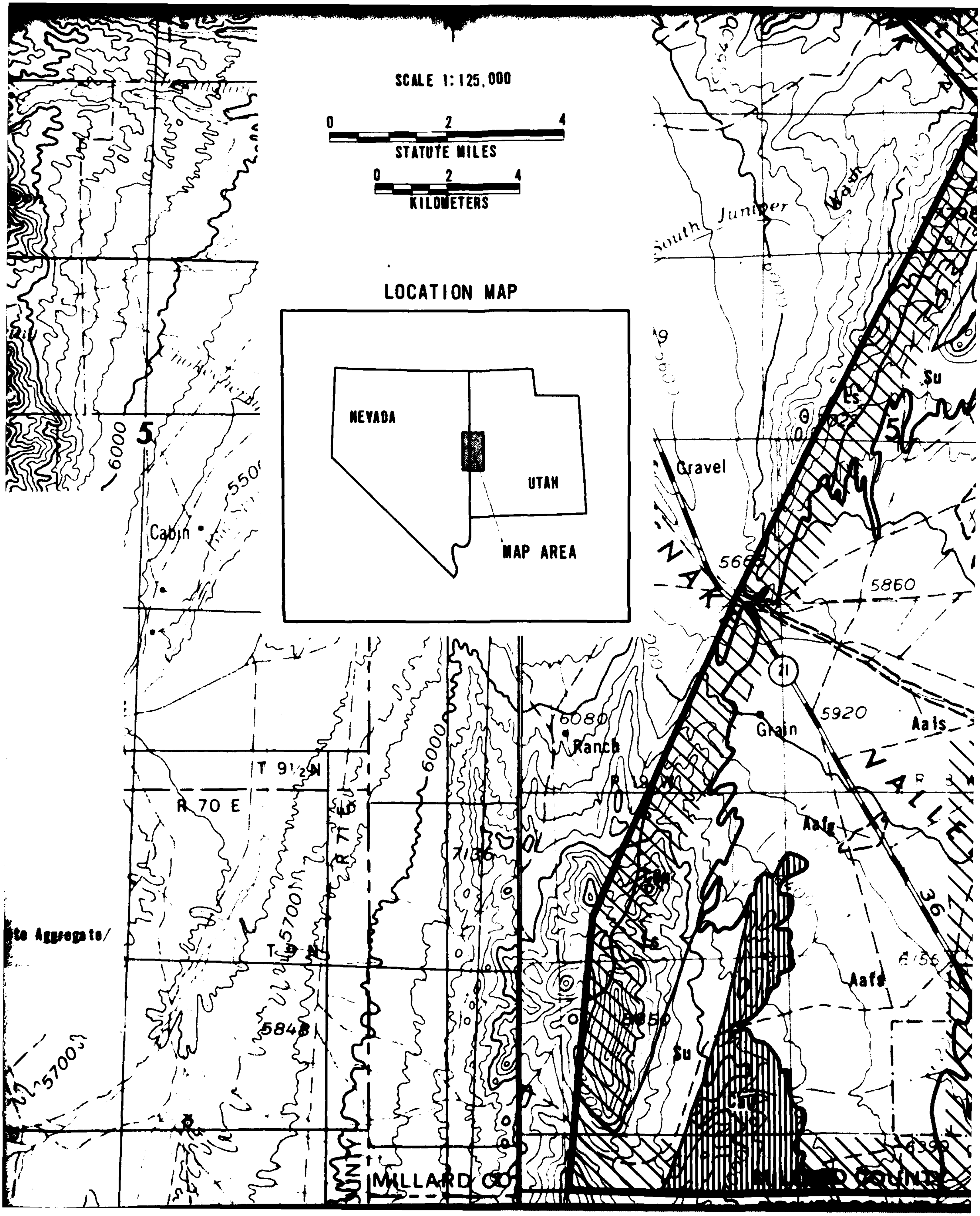
ROCK SOURCES

Class I - Potentially Suitable Crushed Rock, Concrete Aggregate and Road-Base Materials Source

BASIN-FILL AND ROCK SOURCES

Class II - Possibly Unsuitable Coarse, Fine and/or Crushed Ro... Potentially Suitable Road-Base Material Source

Class III - Unsuitable Coarse, Fine and/or Crushed Rock Concrete Aggregate or Road-Base Material Source



SCALE 1:125,000
0
2
4
STATUTE MILES
0
2
4
KILOMETERS
LOCATION MAP
NEVADA
UTAH
MAP AREA
South Juniper Wash
Gravel
Cabin
Su
Ls
5860
5920
6080
Ranch
Grain
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T 9½ N
R 70 E
7136
5700
5848
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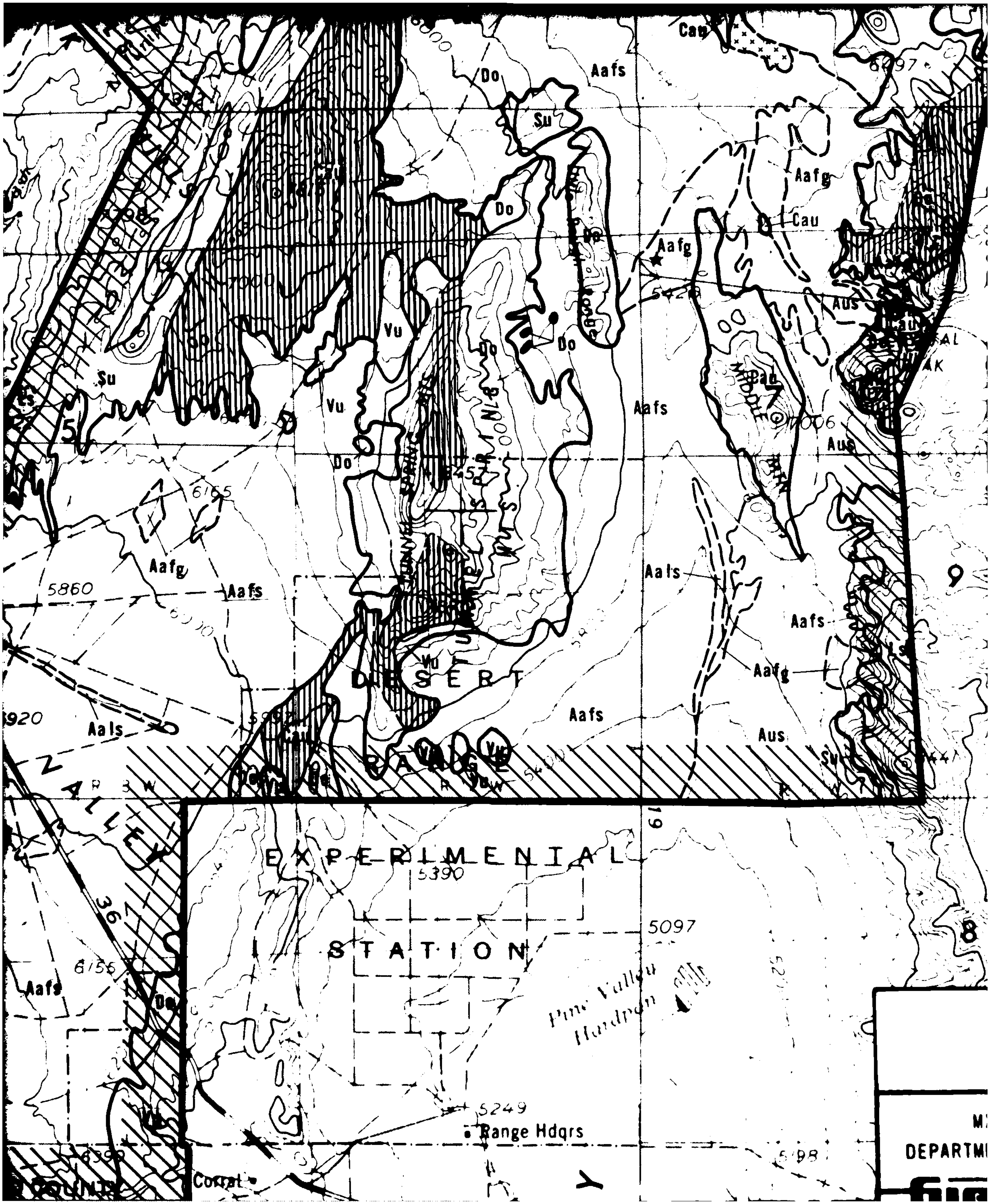
Aggregate/
MILLARD CO


Aafs
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Pine Valley
Hardpan
5860
6155
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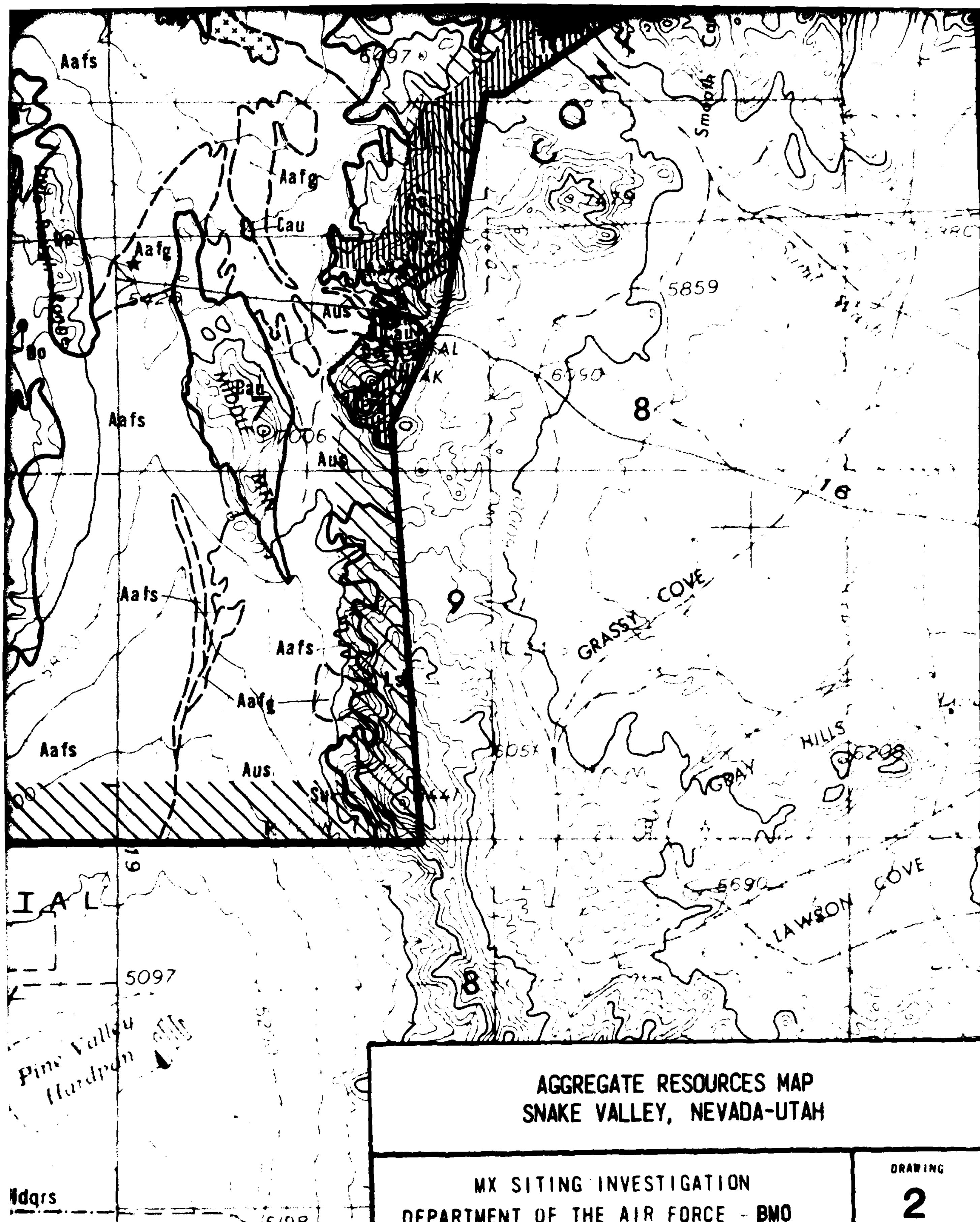

AGGREGATE RESOURCES MAP
SNAKE VALLEY, NEVADA-UTAH

MX SITING INVESTIGATION
DEPARTMENT OF THE AIR FORCE - BMO

DRAWING
2

FUGRO NATIONAL, INC.

DAT
FILM